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MINIATURE PRECISION DETONATOR

SPACE ORDNANCE SYSTEMS, INC.
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JUNE 1974

FINAL REPORT FOR PERIOD JULY 1973 - MAY 1974

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This report describes a two-pin miniature precision detonator (MPD) for use in space-limited safety and arming (S&A) devices providing multipoint initiation of missile warheads. The detonator is a fast-acting electric type not larger than the single-pin USAF Microdetonator, P/N 66A11302, but with less sensitivity (80 milliamperes versus the specified 10 milliamperes for the Microdetonator no-fire). The foremost purpose of the design is simultaneous initiation

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of a number of detonators. This is best achieved by a very short firing time for the nominal unit. Two header designs were evolved: (1) platinum-tungsten alloy 479 wire bridge and (2) thin-film palladium bridge, vacuum deposited on a vacuum deposited chromium base. The two headers were used to make full-up detonators. Both headers and detonators were tested using a capacitive discharge firing unit (22-microfarad capacitor charged to 30 to 40 volts). Test units were fired by mercury relay. Firing times were 4 to 5 microseconds with ±1.0 microsecond jitter for the wire bridge and 1 microsecond ±0.5 microsecond for deposited bridge. The deposited bridge units were therefore preferable for use where simultaneity is important. Another finding was that dimple-ended aluminum cases are superior in gap transfers into PBXN-5 acceptor when compared to equivalent mass stainless steel cases, either dimpled or flat bottomed. Also, flat bottomed stainless steel cases perform better than dimpled cases. Test data on the two headers and the two miniature detonators made from them are included.

SUMMARY

- The Deposited Bridge Miniature Precision Detonator (DBMPD) and the Wire Bridge Miniature Precision Detonator (WBMPD) will function in less than ten microseconds with less than one microsecond jitter. The minimum firing stimulus is the discharge of a 22-microfarad capacitor at approximately 40 volts through the MPD bridge.

- The MPD manufacturing procedure must be altered to eliminate the MPD functional problems. The changes are in the primer charge slurry blend and the soldering sealing technique.

- The no-fire current for WBMPD and DBMPD is approximately 0.10 ampere.

- The MPD output was not affected by the environmental tests (T&H and Shock). The leads of approximately 50% of the MPD rusted off during the T&H test. Detonators failed functionally after the tests but the failures were attributed to desensitization of the primer charge during manufacturing.

- The MPD will reliably initiate PBXN-5 at 30 Kpsi through 0.005-inch-thick (maximum) aluminum or stainless steel closure across a 0.075 inch (maximum) air gap.

- Three 0.022-inch-thick steel barriers are required to confine the MPD output.

- During the week of June 10, 1974, eleven flat-bottomed stainless steel cases were loaded with 17 milligrams HMX plus 24 milligrams, lead azide. These were fired with an electric match to determine the gap transfer characteristics into a PBXN-5 acceptor with a 5-mil aluminum closure. At 0.250 inch gap, 5/5 transfers occurred. At 0.500 inch, 4/6 transfers occurred. This contrasts to approximately 0.075 inch gap for reliable transfer with the dimpled stainless steel can.

- The techniques utilized in manufacture of the Deposited Bridge Miniature Precision Detonator headers are not adequate to insure consistent and reliable function and must be improved.

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PREFACE

This report documents work performed by Space Ordnance Systems, Inc., 375 Santa Trinita Avenue, Sunnyvale, California 94086 under Contract No. F08635-73-C-0156 with the Air Force Armament Laboratory, Eglin Air Force Base, Florida. Mr. Richard B. Mabry, Jr. (DLJF) managed the program for the Armament Laboratory. This effort was conducted during the period from July 1973 to May 1974.

This report also documents a reliability evaluation of deposited bridge headers performed by J.J. Bart, E.A. Doyle and C. J. Salvo of Rome Air Development Center/RBRP.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

FENDRICK J. SMITH, JR., Colonel, USAF
Chief, Fuzes and Munition Control Systems Division

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SECTION I

INTRODUCTION

A program was undertaken to determine the feasibility of designing and building a miniature detonator which will function in less than 10 microseconds, with less than one microsecond jitter. The detonator size was specified to be comparable to the USAF Microdetonator P/N 66A11302 (SOS 06401) developed for Air Force WAAPM program, but with the following differences:

- Less sensitivity than the Microdetonator (80 milliamperes no-fire, compared to 10 milliamperes specified for the Microdetonator)
- Lead azide rather than lead styphnate used in the primer

Both alloy 479 platinum-tungsten wire bridges and thin-film, vacuum-deposited chromium-palladium bridges were investigated. To meet the less than 10 microsecond firing time requirement, capacitive discharge firing units were used. With 22 microfarad capacitor charged to 40 volts dc, fired by a mercury relay, firing times of 4-5 microseconds and 1.0 microsecond jitter were achieved with wire bridges. Deposited bridges fired in 1.0 microsecond and 0.5 microsecond jitter.

The new detonator was called the Miniature Precision Detonator (MPD).

This document describes the development program and the results of the development verification. The one exception to the test plan is that an additional 100 Wire Bridge MPDs were included in the test matrix.

SECTION II

OBJECTIVES

2.1 Firing Time

Capacitor discharge firing in less than 10 microseconds and with less than one microsecond jitter.

2.2 No-Fire Current

Establish no-fire current. The no-fire current is to be greater than 0.080 ampere.

2.3 Detonator Output

Characterize the detonator output by the following tests.

2.3.1 Dent Output Test. Test detonators into steel witness plate to compare dent outputs.

2.3.2 Gap Test. Determine the maximum air gap across which the detonator will initiate a PBX-N5 booster.

2.3.3 Booster (Variable Closure) Initiation Test. Determine the maximum booster closure (aluminum and stainless steel) thickness through which the detonator will initiate PBX-N5.

2.3.4 Barrier Test. Determine the barrier necessary to confine the detonator output for safety reasons.

2.4 Temperature and Humidity Test

Determine if detonators will resist degradation when exposed to the temperature and humidity environment.

2.5 Shock Test

Determine if detonators will withstand the 1500-g shock test without degradation.

SECTION III

MINIATURE PRECISION DETONATOR DESIGN

3.0 General

The Miniature Precision Detonator (MPD) design is shown in SOS Drawing 10314 (Appendix A). The electrical initiation characteristics and the detonator material are modified from the Microdetonator (SOS 06401) to effect a design meeting the requirements of the contract.

3.1 Configuration

The configuration of the MPD (SOS Drawing 10314) is essentially identical to that of Microdetonator (SOS Drawing 06401), Spec. 66A11302, Rev. D, except for two lead pins rather than one pin, and a steel case rather than aluminum. The MPD diameter is 0.100 inch maximum. The lead-pin length is 0.23 inch. The two lead pins are electrically isolated from the case by a fused glass bead.

3.2 Header Assembly

The two types of header assemblies are shown in SOS Drawing 10362 and 10507 (Appendix A).

3.2.1 Header. The header configuration is shown in SOS Drawing 10353 (Appendix A). A glass-to-metal header is employed in the design. The sleeve and the two lead pins are Kovar with gold plating. The insulating seal is glass. The lead pin is 0.012 ± 0.001 inch in diameter by 0.25 inch long.

3.2.2 Bridge. Detonators with two types of bridge construction were developed: (1) wire bridge, and (2) vapor-deposited bridge. The two types of bridge are discussed below.

3.2.2.1 Wire Bridge. Several types of bridgewires were welded onto headers, buttered with primer charge (lead azide) and fired. The tests were primarily directed towards obtaining the fast function time of less than 10 microseconds. The 479 alloy (platinum-tungsten) wire, 0.0004-inch diameter, met the requirement.

Initial tests were performed with one-pin headers, SOS 08543. The tests showed that, with a given stimulus, shortening the bridge element which, in turn, lowers the bridge resistance, shortened the function time. The lowest resistances ranged between 2.0 to 2.7 ohms.

With the two-pin header, SOS 10353 (Appendix A), the shorter bridge was not attained because the header pin-to-pin spacing was wider than the pin-to-sleeve spacing of the one-pin header. The bridge resistance ranged between 3.8 to 4.8 ohms. It was noted that welding the bridgewire with high energy seemed to result in a higher frequency of fast function time (2 to 3 microseconds) but not repeatably. Bridgewires were welded with minimum energy so as not to overly deform the wire at the weld spots.

3.2.2.2 Vapor Deposited Bridge. The bridge configuration is shown in SOS Drawing 10506 (Appendix A). The element itself is the same as the bridge designed for the one-pin Microdetonator header, SOS 08892. To vapor deposit a bridge on a header, the glass surface must be smooth and clean.

The header supplier was asked to polish the glass surface in an electric fusion furnace but the effort did not succeed. The entire glass bead melted, and the pins moved so that the header no longer met the dimensions specified in SOS Drawing 10353.

The one-pin headers of the Microdetonator were routinely polished in the furnace. In the one-pin configuration, the single axial pin could be maintained in position by a support which did not induce any stress relative to the shell. In the case of the two-pin models, there was no immediate solution to pin support without inducing some undesirable force moments causing the pins to move out of specification. The inability to polish the two-pin headers in the supplier's furnace was not anticipated.

It was decided to polish the headers in-house. Headers with large voids or cracks on the glass surface were segregated out beforehand. The area of glass shown in Figure B-8, Appendix B, was polished with a small acetylene-oxygen torch. Attempt was made to polish the whole surface, but the glass retracted downward, creating a void around each pin.

A polished glass surface on the header is essential to success in vapor deposition of a pin-to-pin bridge across the glass. A bridge cannot be deposited across or through a large void.

The in-house polishing with oxy-acetylene torch could also result in damaged headers if flame exposure were too concentrated or for too long a period. For assurance that headers were not damaged in polishing, the flame exposure was restricted to the area immediately between the two pins. Very few deposited bridge headers so prepared were lost because of open circuits from bad depositions. For example, in two runs of 396 headers only three headers were rejected. Thus, in 792 headers only six were defective in the deposition process.

The polished headers were cleaned in hot water, hot acetone, and hot alcohol to remove any soluble salts and oily substances. The headers were dried with dry nitrogen and stored in nitrogen atmosphere. The deposition fixtures (SOS 54799) were cleaned in acetone and alcohol and dried with dry nitrogen. No part was handled after cleaning without cotton gloves or clean tweezers. The headers were placed in the fixture (SOS 54799), Figure B-8, Appendix B.

The deposition work was done by Alphadyne, Inc., Sunnyvale, California. Three runs were made, and the results are given in Appendix B, Tables B-1, B-2 and B-3. The data show the location of the header in the fixture versus the bridge resistance. The deposition consists of approximately 200 Ångstrom of chromium base with 4000, 4200, and 4800 Ångstrom of paladium for Runs #1, #2, and #3, respectively. Deposition thickness was increased for successive uses of the mask to compensate for closure of the mask apertures by residual deposition. The step increases in thickness were determined by experience as required to maintain the bridge resistance.

In general, the bridge resistance decreased, going from top to bottom. This was due to the positioning of the vapor deposition fixture within the deposition chamber. The irregular resistances are mainly due to the headers not being up against the deposition mask because the header is stuck in the fixture hole or the header top is not perpendicular.

The vapor deposition is done at elevated temperature (150°C) and then brought down to room temperature. Normally, a poor bond will peel off in the cooling process. This means that the cooling process provides an automatic selection process to identify the poor bonds. Deposited bridges which survive the cooling stresses are probably satisfactory units.

Some of the headers in the first two runs had cracked glass. It was certain that it was not due to the polishing operation because the polished headers were 100% inspected for cracks and quality of polish. For Run #3, the headers were cleaned in 150°F water rather than boiling water (212°F). Some cracking occurred when the headers were boiled in water. After

positioning in the fixture, headers were 100% inspected. No cracks were noted. Before the bridge was deposited, both headers and fixture were heated in the deposition chamber to remove any moisture present on the headers.

For Run #3, the time to reach the temperature was lengthened from 8 minutes to 15 minutes to reduce thermal shock. Very few headers were lost due to cracked glass in Run #3. Headers for the test were selected from the three runs. The headers were selected for bridge resistance (2.5 to 4.5 ohms). All headers were visually inspected for proper bridge. Function tests showed that headers with bridge resistance above 5 ohms did not always initiate the primer charge.

One hundred vapor deposited bridge headers (SOS 10507) were shipped to AFATL, Eglin Air Force Base, Florida.

3.2.3 Primer Charge. Lead azide and silver azide were suggested for the primer charge in the AFATL specification. Lead azide (RD 1333) particle size was found to be much larger than the bridge, and therefore the explosive was milled. Colloidal lead azide was obtained from Naval Weapons Center, China Lake, California. The particle size of the milled lead azide and the colloidal lead azide were about the same.

Tests made with both types of lead azide showed no difference between the two. The lead azide is applied to the header in a slurry form. The slurry consists of lead azide, butyl acetate, and 1% Viton "A" binder. The buttered header is dried at 170°F for 30 minutes minimum. Milled lead azide was used on all test hardware.

One problem noted was that the slurry dried with a concave surface over the bridge area. This is depicted in Figure B-9A, Appendix B. This does not present a problem with the one-pin header assembly because the bridge is located underneath the crest area of the primer charge. A thin layer of primer charge over the bridge area may cause the bridge not to heat a critical mass and, hence, result in long function time. In the worst condition, the assembly may not function at all. Header assemblies for the test were inspected for thin primer charge over the bridge area and exposed bridge.

After the test assemblies were fabricated, an investigation was made to find a solution to the before-mentioned problem. Addition of isopropyl alcohol to the slurry mix was found to cure the problem. The addition of alcohol allowed the slurry to dry more slowly. The header assembly buttered with this slurry is depicted in Figure B-9B.

3.3 Case Assembly

3.3.1 Case. The case configuration is shown in SOS Drawing 10352, Appendix A. The case material is stainless steel with the same dimple end as the Microdetonator case. The case is tin plated for solderability. The bottom thickness is 0.004 ± 0.001 inch. It would be desirable to have 0.002 to 0.003-inch-thick bottom so that the mass of the end plate (case bottom) will be nearly the same as the mass of the Microdetonator aluminum case bottom. Detonators fabricated with these cases will nearly have the same output. That is, when the detonators are functioned, the velocity of the end plates should be nearly the same. It turns out that the case bottom thickness is approximately 0.005 inch which is the same as the wall thickness. Stainless steel cannot be coined to a thinner thickness; therefore, the only way to thin the case bottom is by machining or lapping.

In the early stage of the program, a series of tests to obtain some data on how the case bottom thickness affects the detonator output were made. A smaller ID (0.081 inch) steel case was tested with the same amount of transfer and output charges as the Microdetonator. Prior to loading, the bottom of four cases was thinned to 0.005 inch and shaped to have the same dimple as the Microdetonator case. The loaded cases were tested into WAAPM HMX boosters at 0.150 inch air gap (test gap for Microdetonator). All transferred successfully. This test was repeated with five 0.007- and five 0.009-inch-thick bottom cases. Each initiated its respective booster. The same test was repeated with the first cases (SOS 10353) shipped by the vendor to SOS for evaluation. In five tests, the case assemblies initiated their respective boosters.

The standard aluminum case Microdetonator is dimpled as experience showed would increase the output efficiency due to the "flying plate" principle. The first tests with stainless steel cases used a dimpled case similar to the aluminum cases except for wall thickness which was reduced from 8 mils to 5 mils to maintain approximate mass equivalency between the two cases. The same dimple radii were used.

The stainless steel dimpled cases were found to be inferior to aluminum in gap transfer tests. Stainless steel transferred at 0.075 inch, compared to as much as 1.0 inch for aluminum. The stainless steel case wall thickness was reduced to approximately 2 mils to bring the mass equivalence more closely to that of aluminum. Gap firing tests with the 2-mil dimpled stainless steel cases showed reliable transfer at approximately 0.100 inch, still much less than achieved by the equivalent aluminum cases.

The poor results with the dimpled cans suggested the use of normal fragmentation as the transfer mode and so flat-bottom cases were tried. A total of 14 flat-bottom units were assembled. Three of these were removed for dent output evaluation over several gaps. The purpose of these dent firings was to provide a gross evaluation of the fragmentation coverage and depth relative to several selected gap distances. (Dent depth firings are not good criteria for evaluating effectiveness of transfer but indicate only relative consistency of output between similar units.) The remaining 11 units were fired into PBXN-5 boosters with 5-mil aluminum closures, at gaps of 0.250 and 0.500 inch. The results were 5 out of 5 successful transfers at 0.250 and 4 out of 6 successful at 0.500 inch. This showed that flat-bottomed stainless steel cases were superior to the dimpled ones.

It is recommended that stainless steel test configurations be standardized on flat-bottomed cases in all future tests.

3.3.2 Transfer Charge. The same transfer charge (lead azide) as in the Microdetonator was used in the test assembly. The amount was increased to compensate for the larger ID of the stainless steel case (SOS 10353). The charge was 23 ± 2 milligrams of lead azide consolidated at 15 Kpsi; reference column height was 0.060 inch.

3.3.3 Output Charge. The same output charge (HMX) as in the Microdetonator was used in the test assembly. The amount was increased to compensate for the larger ID of the case. The charge was 18 ± 2 milligrams of HMX consolidated at 15 Kpsi; reference column height was 0.100 inch.

3.4 Sealant

The header-to-case interface was sealed with Sn63 solder. A 0.027-inch-diameter solder sphere with Kester Paste Flux was positioned at the interface and soldered with an RF-induction heater. Microdetonators have been solder-sealed using the same method. The Microdetonator aluminum case was plated, and a 0.027-inch-diameter 50 Tin/50 Indium alloy solder sphere was used for its lower melting temperature.

SECTION IV

TESTS

The tests performed for the Miniature Precision Detonator (MPD) are outlined in the Test Plan. By mutual agreement, one hundred wire bridge MPD (SOS 10314-101) were added to the test matrix.

4.1 Leak Test

One hundred ten vapor deposited bridge MPD (SOS 10314-103) and 57 wire bridge MPD (SOS 10314-101) were subjected to the leak test. All MPD with leak rate greater than 1 X 10^{-6} cc/sec of helium were rejected. Remainder of wire bridge MPD were not solder-sealed.

4.2 Temperature and Humidity Test

Thirty-two wire bridge MPD and 32 vapor-deposited bridge MPD were subjected to the 28-day temperature and humidity test in accordance with MIL-STD-331, Test 105. The bridge resistances were measured and recorded before and after completion of the test.

4.3 Shock Test

Fifteen wire bridge MPD and 15 vapor-deposited bridge MPD were subjected to the 15,000 "g" shock test. In each test, 15 MPD were mounted in a carrier and launched with an air gun into a pine board laid on loose sand. (This is the same shock test to which the Microdetonator was subjected.) The shock was applied longitudinally to the detonator centerline and against the output end. Bridge resistances before and after the test were measured and recorded.

4.4 Header Assembly Function Time Test

The test setup is shown in Figure B-1, Appendix B. The two types of header assemblies (SOS 10362 and SOS 10507) were tested by capacitor discharge firing, and the function times were measured and recorded. The tests were performed with 1.0-, 4.7- and 22.0-microfarad capacitors at different voltage levels.

4.5 Header Assembly No-Fire Test

The test setup is shown in Figure B-1, Appendix B. A 30-shot constant current no-fire Bruceton test was performed on both types of header assemblies (SOS 10362 and SOS 10507). The test duration was 5 minutes. The test current was monitored and recorded. The "go" and "no-go" were recorded.

4.6 Detonator Dent Output Test

The test setup is shown in Figure B-2, Appendix B. The detonators were fired into witness plates at 0.250-inch test gap, and the function times were measured and recorded. The dent depths were measured and recorded.

4.7 Detonator Gap Test

The test setup is shown in Figure B-3, Appendix B. A 20-shot gap test was performed. This test showed the initiation of PBXN-5 boosters (with 0.005-inch-thick aluminum closure) by the detonators across variable air gap. Function times of the detonators were measured and recorded. The transfer and no-transfer were recorded.

4.8 Booster (Variable Closure) Initiation Test

The test setup is shown in Figure B-3, Appendix B. Test series were performed with both stainless steel and aluminum closure boosters. This test indicated the initiation of PBXN-5 boosters with either stainless steel closure (various thickness) or aluminum closure (various thickness) by the detonators across a constant air gap. Function times of the detonators were measured and recorded. The transfer and no-transfer were recorded.

4.9 Steel Barrier Test

The test setup is shown in Figure B-4, Appendix B. A 10-shot steel barrier test was performed. The effect on each steel barrier was observed and recorded. The detonator function times were measured and recorded.

SECTION V

TEST EQUIPMENT

5.1 Test Equipment

The MPD testing used the following major items of test equipment:

Firing Unit, SOS 54748
Capacitors (1.0, 4.7 and 22.0 microfarads)
D.C. Power Supply (2 each)
Oscilloscope, Tektronix, 555
Oscilloscope Camera, Polaroid
Memoscope, Tektronix, 564B
Velocity Test Box, SOS 06716
Current Probe
Constant Current Source, SOS 06258
Digital Voltmeter, Hewlett Packard
Detonator Firing Fixture
Header Assembly Test Fixture
Dial Indicator
Feeler Gage
Witness Plate, SOS 54134
Detonator Mounting Clips
Leak Detector, Ion Equipment Corporation
Temperature-Humidity Chamber, Conrad
Air Gun (Launcher for Shock Test)

5.2 Special Test Fixtures

In addition to the standard items of test equipment, a number of special fixtures were made. These are shown in the figures of Appendix B.

SECTION VI

MEASUREMENT TECHNIQUES

The most difficult measurement to make reliably was the function time. Data obtained by several methods were found to be difficult to interpret and/or the response of the system too slow. The best method of measuring the function time was by monitoring the firing current and the Make-System.

When the primer charge initiates, ionization takes place and short-circuits the header leads. A sudden increase in firing current is noted at this time. The principle of ionization is also employed in the Make-System, as shown in Figure B-1, Appendix B. When the primer charge initiates, ionization takes place and short-circuits the two Make-System contacts. This completes a circuit and discharges a charged capacitor which is monitored.

Figure B-10A, Appendix B, shows typical firing current traces through a deposited bridge (DB) -- top trace, and wire bridge (WB) -- bottom trace. The firing stimulus for these tests was the discharge of a 22-microfarad capacitor at 40 volts.

Figure B-10B shows typical header assembly firing current traces and Make-System output traces. Both Wire Bridge Header Assembly (WBHA) and Deposited Bridge Header Assembly (DBHA) were tested. The top trace and the one next-to-bottom are firing current and Make-System output of the same Deposited Bridge Header Assembly (SOS 10507) test, respectively. The second-to-top trace and the bottom trace are firing current and Make-System output of the same Wire Bridge Header Assembly test, respectively. Note that the time of the sudden current change nearly coincides with the Make-System output time.

Figure B-10C shows the firing current and Make-System output traces of Miniature Precision Detonator (MPD) tests. The MPD were tested as shown in Figure B-5A, Appendix B. The top and second-from-bottom traces of Figure B-10C are from a deposited bridge MPD (SOS 10314-103) test. The second-from-top and bottom traces are of a wire bridge MPD (SOS 10314-101 test. Note that there is about 0.8-microsecond difference between time of sudden firing current change and the Make-System output time of each MPD. This difference in time is the total time from the initiation of the transfer charge to the detonation of the output charge.

Figure B-5B shows the Make-System wiring for the development verification tests. This method is less repeatable but, if the wiring were done as shown in Figure B-5A, the output of the MPD would be distorted. In all tests, monitoring the firing current was the primary method of measuring the function time, and for the MPD tests, 0.8 ± 0.2 microsecond was added to the data to give the MPD function time. All traces were recorded by oscilloscope/camera. A memoscope was used as a redundant recording system.

SECTION VII

DATA ANALYSES AND CONCLUSIONS

7.0 General

The test data are given in Appendix C. A summary of the test data is given in Tables C-1 and C-2 of Appendix C.

7.1 Temperature-Humidity Test

After 17 days of the 28-day Temperature-Humidity (T&H) test, the MPD leads were noted to be rusting and some of the leads broken off. With the concurrence of AFATL by telephone, the T&H test was terminated after the 17-day exposure. One possible cause of rusting may have been due to some reaction caused by the residue Kester Paste Flux. The flux is activated and may not have been completely cleaned off with hot detergent water after the soldering operation.

A good quality nonporous gold plate is recommended as a possible method of minimizing this problem. Visual inspection showed that the other MPD parts were not affected mechanically by the T&H test.

For T&H test data see Appendix C, Table C-3, Data Sheets #1, #2 and #3 for the wire bridge and Sheets #19, #20 and #21 for the deposited bridge.

7.2 Shock Test

The shock test did not mechanically affect the MPD. The bridge resistance measured before and after the shock test revealed that all the resistances were about the same except for Specimen 338. The resistance increased by approximately 0.4 ohm.

For shock test data, see Appendix C, Table C-3, Data Sheets #4 for wire bridge and Sheet #22 for deposited bridge.

7.3 Header Assembly Function Time

The header assembly function time test data showed that the Wire Bridge Header Assembly (SOS 10362) will function in less than 10 microseconds with less than one microsecond jitter.

The minimum stimulus is the discharge of a 22-microfarad capacitor at 30 volts through the bridge. The minimum stimulus for the Deposited Bridge Header Assembly (SOS 10507) to meet the function time specification is the discharge of a 22-microfarad capacitor at 40 volts through the bridge. When the Deposited Bridge Header Assembly functions with any firing stimulus, the function time is always one microsecond or less.

For test data see Appendix C, Table C-3, as follows:

Wire Bridge Header Assembly:

Sheet 14 (Specimens 196-200)
Sheet 15 (Specimens 201-205)

Deposited Bridge Header Assembly:

Sheet 37 (Specimens 571-575)
Sheet 38
Sheet 39 (Specimens 591-599)

7.4 Bruceton No-Fire Test

The no-fire test on the header assemblies showed that the $\bar{X}$ no-fire level for the Wire Bridge Header Assembly and the Deposited Bridge Header Assembly is about 123 milliamperes with a standard deviation (S.D.) of 5.6 milliamperes for the Deposited Bridge and an S.D. of 3.9 for the Wire Bridge. The no-fire testing was conducted by the Bruceton method of Appendix A to NAVORD Report 2101. Calculations of the $\bar{X}$ values are given below:

WIRE BRIDGE HEADER ASSEMBLY NO-FIRE

BRUCETON CALCULATION

Current (milliampere)	i	X	0	in_i	i^2n_i
115	0	0	2	0	0
120	1	2	7	7	7
125	2	7	5	10	20
130	3	3	0	0	0
			n = .14	A = 17	B = 27

$C = 115$

$d = 5$

$A = 17$

$n = 14$

$$\bar{X} = C + d\left(\frac{A}{n} \pm \frac{1}{2}\right) = 123.6 \text{ milliamperes}$$

$$M = \frac{nB - A^2}{n^2}$$

$$S = \frac{(M)}{0.623} + 0.056 = 0.785$$

$$\text{S.D.} = Sd = 3.924$$

DEPOSITED BRIDGE HEADER ASSEMBLY NO-FIRE

BRUCETON CALCULATION

Current (milliampere)	i	X	0	in_i	i^2n_i
115	0	1	2	0	0
120	1	3	2	2	2
125	2	3	2	4	8
130	3	3	0	0	0
			n = 6	A = 6	B = 10

$$C = 115$$

$$d = 5$$

$$A = 6$$

$$n = 6$$

$$\bar{X} = C + d\left(\frac{A}{n} \pm \frac{1}{2}\right) = 122.5 \text{ milliamperes}$$

$$M = \frac{nB - A^2}{n^2}$$

$$S = \frac{(M)}{0.623} + 0.056 = 1.126$$

$$S.D. = Sd = 5.630$$

For no-fire test data see Appendix C, Table C-3, Sheets #16 and #17.

7.5 Function Tests

All MPDs did not function. Recorded data indicated that the proper stimulus was applied to each unit. The firing stimulus for the Wire Bridge MPD (WBMPD) was the discharge of a 22-microfarad capacitor at 30 volts. For the Deposited Bridge MPD (DBMPD) the stimulus was the discharge of a 22-microfarad capacitor at 40 volts.

A smaller percentage functioned after being exposed to the shock test and T&H test. WBMPD Specimens 48 to 62 which were not exposed to any environmental test were functionally tested first. These all functioned with good function times. WBMPD Specimens 33 to 47 were shock-tested and functionally tested next. Two of the first 7 failed to function. The remaining 8 shocked WBMPD and the 15 shocked DBMPD were sent out for X-ray. The 2 failed units and 15 each of the two types of MPD which were not exposed to any environmental test were also sent out for X-ray as comparison units. The X-ray did not show any difference between the units.

Fifteen T&H WBMPD were functionally tested next, but several failed to function. These failed WBMPD, and the MPD which were X-rayed, were sent out to be N-rayed. The N-ray showed no difference between the units and showed that the sealed MPDs were not contaminated by flux. The 15 WBMPD N-rayed for comparison were not solder-sealed and, therefore, free of flux. Higher percentage of the DBMPD failed to function. All these MPD were solder-sealed.

Two failed-T&H MPD of each type were dissected on the output end, and the explosives were removed. A pressure of 45 psi was applied to the output end, and the header end was immersed in alcohol to check for possible leaks. There were no visible leaks. This indicates that the T&H failures were not due to moisture getting into the units.

Several of the failed units were dissected on the header end. These units showed blackening of the primer charge around the bridge area, due to the attempted functioning.

Unsoldered MPDs (Specimens 48 to 62, 72 to 100) all functioned. This indicated that another possible cause of failure may be due to overheating the parts during the soldering operation. An inert MPD with 0.00012-inch-diameter tungsten bridge was placed into the soldering fixture and heated with the RF-induction heater. The settings were the same as previously used. Tungsten bridge was used because of its high temperature coefficient of resistivity.

The resistance of the bridge was monitored during the heating cycle and the peak temperature calculated out to be approximately 550°F. It is known that lead azide will decompose at a higher temperature, and the effect of the temperature on the binder material (Viton "A") is unknown. The effects of overheating the primer charge are noted in the tests of Wire Bridge Header Assemblies that did not function during the no-fire test. Attempts were made to functionally test these units (Specimens 221, 222, 224, 226, etc.), but only one (Specimen 232) of 14 functioned.

It was noted the unsoldered MPDs (Specimens 48 to 62, 72 to 100) all functioned. All the header assemblies for the header assembly function tests and header assemblies built into MPDs were fabricated at the same time. An additional 30 deposited header assemblies were fabricated. Eight assemblies (Specimens 615 to 622) were tested for function time and all functioned properly. Twenty-two header assemblies were built into MPDs and tested without solder-sealing. These MPDs (Specimens 363 to 373, 378 to 388) all functioned properly.

For functional test data see Appendix C, Table C-3, as follows:

WBMPD: Data Sheets 1, 2, 3, 4, 5, 6, 7 and 8

DBMPD: Data Sheets 19, 20, 21, 22, 23, 24, 25 and 26

One can conclude from these tests that the major cause of the problem was due to the overheating of the MPDs during the soldering operation. The overheating probably decomposed part of the primer charge and may have weakened the adhesion strength of the binder so that the primer charge separated from the header during the shock test. This resulted in higher percentage of failures after the shock test.

The Microdetonator has the same primer charge configuration, and the detonator is not affected by the shock test. The primer charge is milled lead styphnate with 2% ethyl cellulose binder. The mechanical strength of the ethyl cellulose is stronger than Viton "A". This may be another possible reason why the Microdetonator will pass the test while the MPD does not.

The overheating problem can be resolved by using lower melting solder such as 50 Tin/50 Indium or using solder rings rather than solder sphere. Use of solder sphere requires longer heating time because the solder has to first melt and then flow around the header/case interface. A solder ring will require only enough heat to melt the solder since the solder is already located around the header/case interface.

Several WBMPDs (Specimens 74, 77, 86, and 100) had short function times of 3 microseconds or less. This was probably due to extreme deformation of the bridgewire at the weld joints or poor primer charge buttering which results in poor coupling between the wire and the primer charge. Both can cause hot spots on the wire. The cause of long function times of Specimens 65 and 82 can also be attributed to poor primer charge buttering. The primer charge buttering problem has been resolved as discussed in paragraph 3.2.3. Of the DBMPDs that functioned, all had function times between 1.1 to 1.6 microseconds.

Another fact noted was that no-function failure rate increased as the test progressed. See Appendix C, Table C-3, Sheet #23, where 3 of 15 units failed during dent output testing. compared to Sheet #26 which show 5 of 10 failures. The data suggest there may be a long-term storage problem using lead azide as the primer charge or, as in this case, the lead azide (primer charge) continued to decompose after the lead azide was partially decomposed during the soldering operation by overheating. This can be verified by storing some parts and periodically testing a few units. All the test hardware, with a few exceptions, were fabricated approximately one month before the first test specimen was functionally tested.

7.6 Effect of Environment Exposures

The dent output test data show that the environmental tests did not affect the MPD output, and the dent output ranged between 0.028 to 0.046 inch.

Refer to Appendix C, Table C-3, data sheets for environmental test data as follows:

ENVIRONMENT	DATA SHEET NUMBERS WBMPD	DATA SHEET NUMBERS DBMPD
T&H	1, 2, 3	19, 20
Shock	4, 5	22
No environments	6	23

7.7 Gap Transfer Capability

The gap test data show that the MPD with dimpled can will initiate a PBXN-5 booster with 0,005-inch-thick aluminum closure reliably across a 0.075-inch air gap or less. In later tests with the flat-bottomed can, 5 out of 5 transfers occurred at 0.250-inch gap into a PBXN-5 acceptor with a 5-mil aluminum closure. These data are not included in the following analysis.

See Appendix C, Table C-3, Sheet #7 and Sheet #8 (Specimens 87-91) for test records relating to gap transfer.

Using the test data in a Bruceton calculation provides:

GAP TRANSFER

BRUCETON CALCULATION

Gap (inch)	i	X	0	in_i	i^2n_i
0.075	0	1	0	0	0
0.100	1	6	1	6	6
0.125	2	2	4	4	8
0.150	3	0	4	0	0
		n = 9		A = 10	B = 14

$$C = 0.075$$

$$d = 0.025$$

$$A = 10$$

$$n = 9$$

$$\bar{X} = C + d\left(\frac{A}{n} \pm \frac{1}{2}\right) = 0.115 \text{ inch}$$

$$M = \frac{nB - A^2}{n^2} = 0.321$$

$$S = \frac{(M)}{0.623} + 0.056 = 0.571$$

$$S.D. = Sd = 0.014$$

7.8 MPD Closure

The booster initiation test data show that the maximum closure thickness through which the MPD will reliably initiate PBXN-5 at 30 Kpsi is estimated as 0.005 inch. This is for both aluminum and stainless steel closure. The air gap was 0.075 inch.

For test data see Appendix C, Table C-3, as follows:

Aluminum closure:

Sheet 8 (Specimens 92 to 96)
Sheet 24

Stainles steel:

Sheet 8 (Specimens 97 to 100)
Sheet 25

7.9 Barrier Tests

The barrier test data show that it requires three 0.022-inch-thick stainless steel barriers to confine the MPD output. Stainless steel, dimpled cases were used in all these tests.

See Appendix B, Figure B-4, for test setup.

Test data are recorded in Appendix C, Table C-3, as follows:

T&H shots:

Sheet 20 (Specimens 321, 322, 323, and 328)
Sheet 21 (Specimen 332)

Nonenvironmental shots:

Sheet 26

7.10 Flat Bottom Can Tests

Tests were conducted initially with stainless steel cases, dimpled in the same configuration as the standard Microdetonator. Past experience with the aluminum cases of the Microdetonator showed better performance in gap transfer if the aluminum cases were shaped in a concave manner, similar to a conical-shaped charge.

The stainless steel, dimpled cases were noted to be inferior to aluminum in transfer capability. Stainless steel cases transferred reliably at 0.075 inch compared to as much as 1.0 inch for aluminum. The stainless steel case walls were reduced to about 0.002 inch to bring the mass equivalency closer to the aluminum cases.

Gap firings with the 0.002 inch dimpled, stainless steel cases showed reliable transfer at approximately 0.100 inch, still much less than the equivalent aluminum cases.

The poor results with the "flying plate" approach with stainless steel cases suggested trial of normal fragmentation as obtained from flat-bottomed cases.

Accordingly, 14 flat-bottomed units were assembled. Three were fired for dent output with results as follows:

Gap (inch)	Dent Output (inch)
0.500	0.020
0.250	0.020
0.150	0.013

Dent tests at 0.250-inch gap with stainless steel, dimpled cases averaged approximately 0.035-inch dent output.

The dent depth firings were made for a gross evaluation of the fragmentation coverage and depth relative to the several selected gap distances. Dent depth is not a good criterion in evaluating the effectiveness of transfer but is valid only as an indicator of relative consistency of output between similar units. To draw conclusion about the gap transfer effectiveness, the remaining 11 units were fired into PBXN-5 boosters having 0.005-inch aluminum closures. Results were:

Gap Distance (inch)	Transfers/Tests
0.250	5/5
0.500	4/6

This showed that flat-bottomed, stainless steel cases were superior to dimpled ones. It is, therefore, recommended that the stainless steel test configuration be standardized on flat-bottomed cases in all future tests.

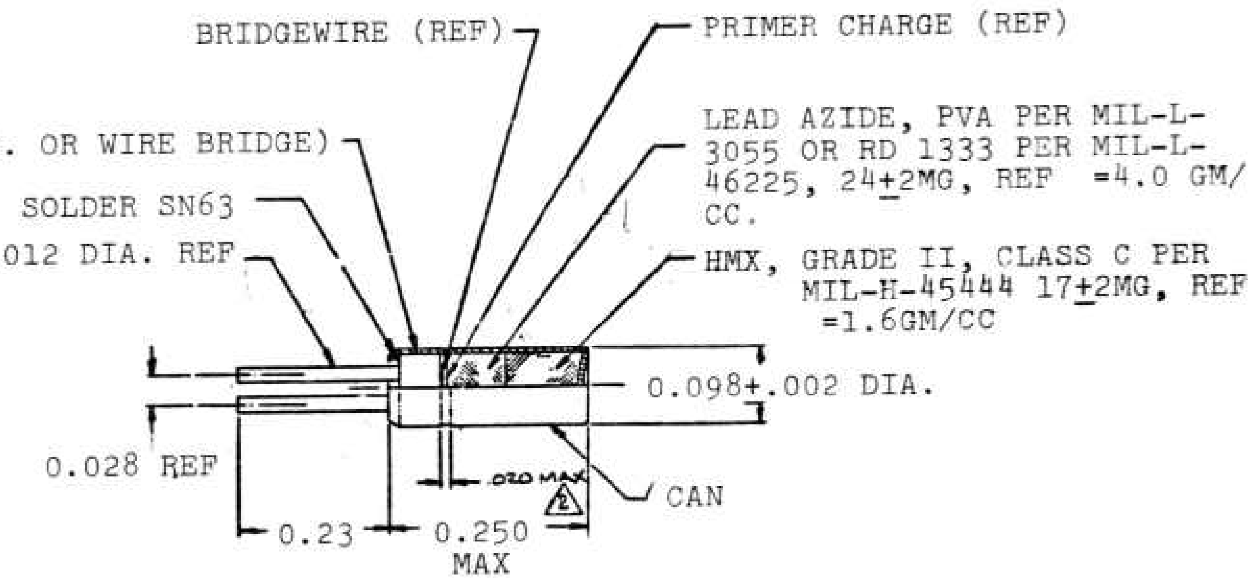
For test records see Appendix C, Table C-3, Sheets #44 and #45.

7.11 RADC Reliability Evaluation of Deposited Bridge Headers

Appendices D and E contain an evaluation of deposited headers of both a single pin configuration (PN 08892) and the two pin DBMPD (PN 10506). These evaluations clearly indicate deficiencies in the manufacturing techniques. Additional work is requried in this area to insure adequate shelf life and reliability necessary for field use.

APPENDIX A

DRAWINGS



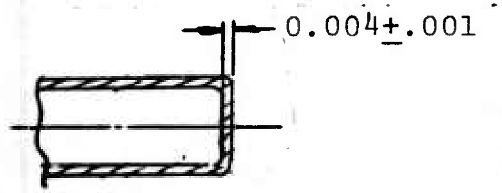
NOTES: (1) Bridgewire resistance shall be 2.0 to 7.0 ohms at 75°±10°F.

2. Diameter reduction of 0.015 max. permitted in area indicated.

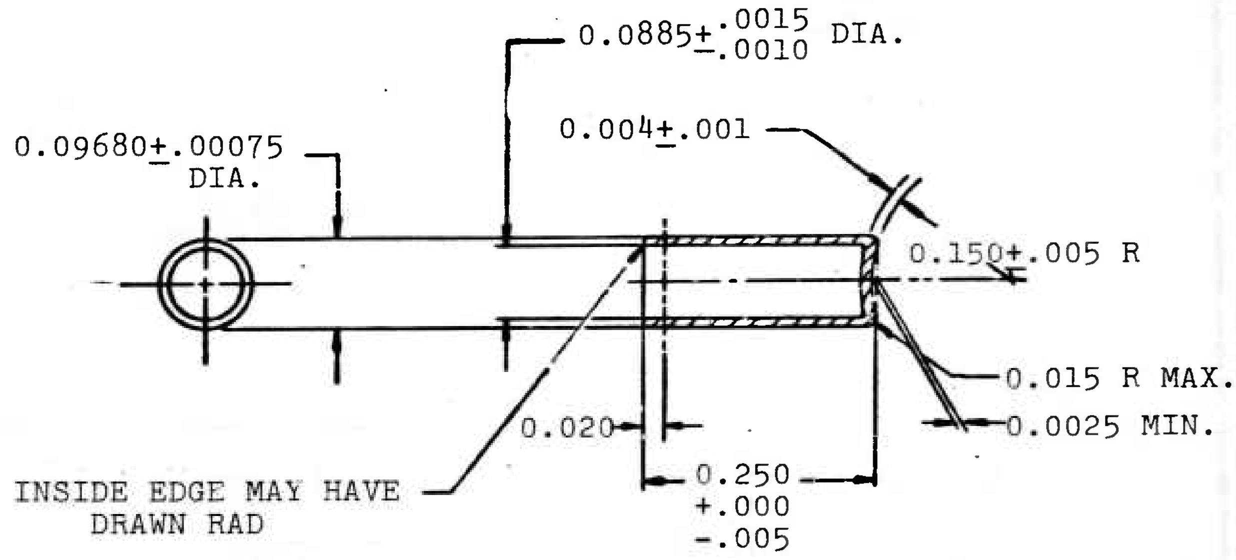
(3) Ref: MP 10314

(4) Recommend 50-50 Tin-Indium solder be used rather than the Sn 63 solder used in test units.

MINIATURE PRECISION
DETONATOR
10314



-2 CONFIGURATION



-1 CONFIGURATION

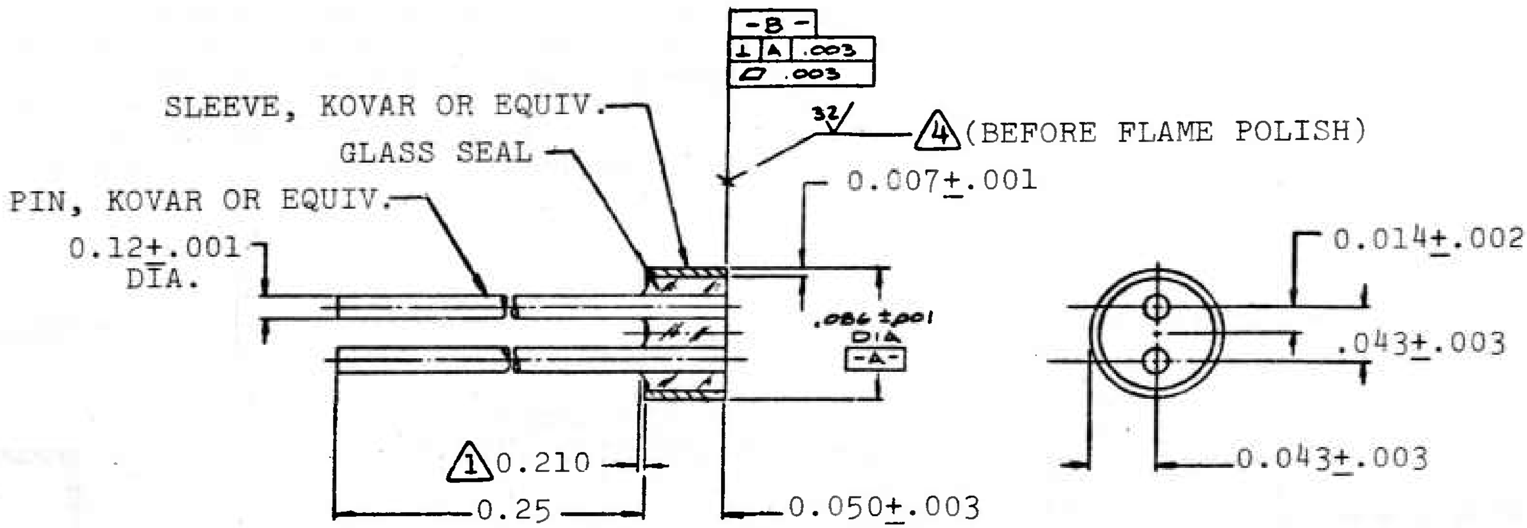
(1) Bright anneal in hydrogen atmosphere for 3 minutes at 1950°-2050°F. after forming cool in still air.

(2) Tin plate per MIL-T-10727, Type I, fused 0.0001 to 0.0003 thick for soldering. Oil fuse in commercial terne oil, #65 or equiv. 475°-500°F. Surface shall be smooth, glossy, and continuous after fusing.

(3) Dimensions apply before plating

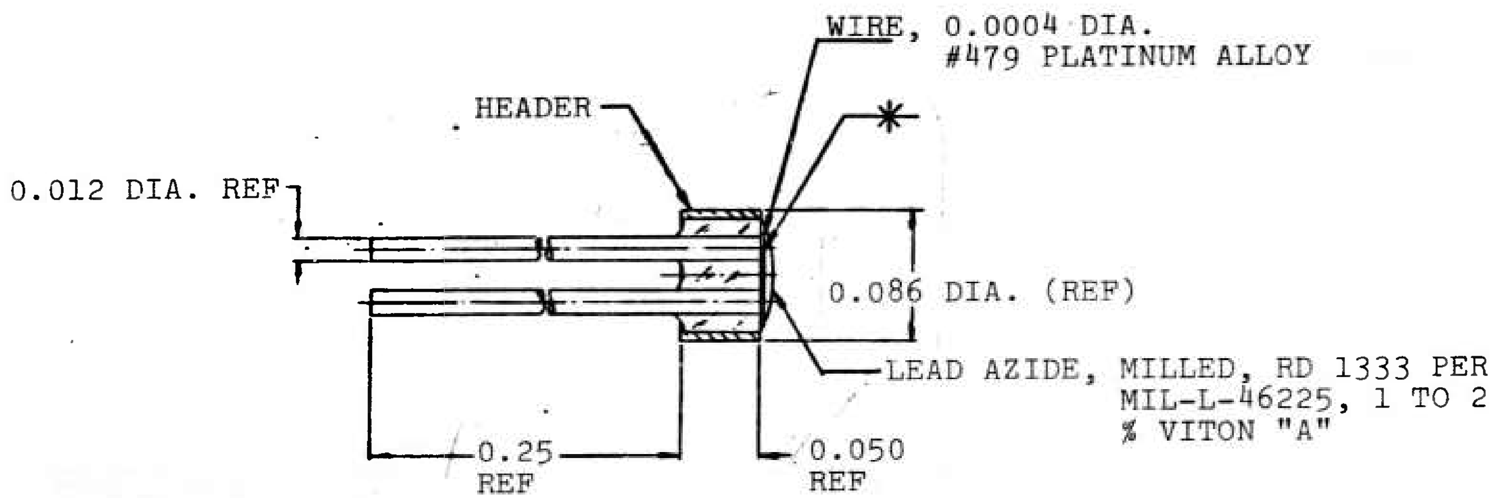
CAN

10352



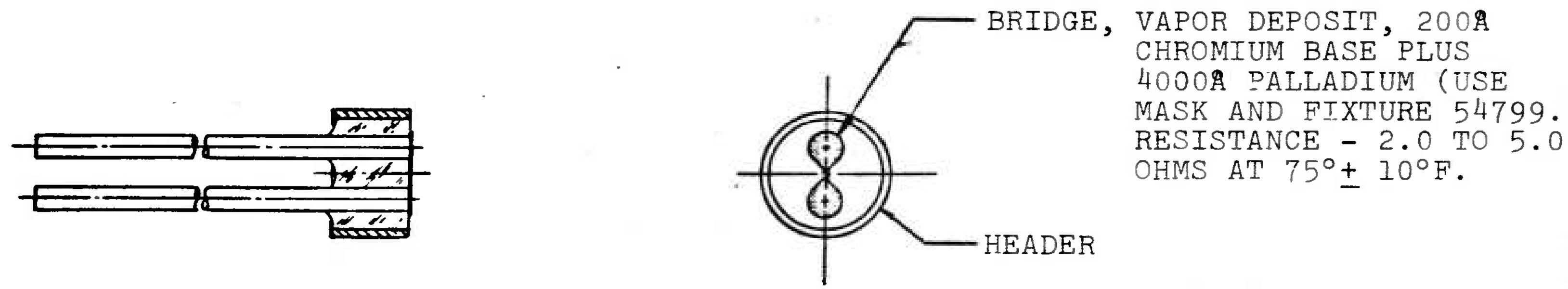
1. Meniscus permitted within limits shown.
(2) All metal surfaces to be gold plated, finish 1.11.1.2 of MIL-STD-171.
(3) Break sharp edges.
4. Flame polish glass at -B- on -103 Assy. only.

HEADER
10353

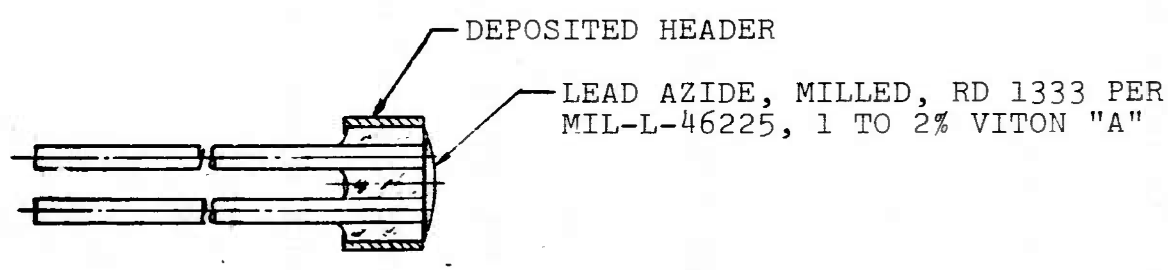


NOTE: No recession is allowed in the header surface between the two pins. Headers will be inspected visually and sorted to eliminate recession.

HEADER ASSEMBLY
10362



DEPOSITED HEADER
10506



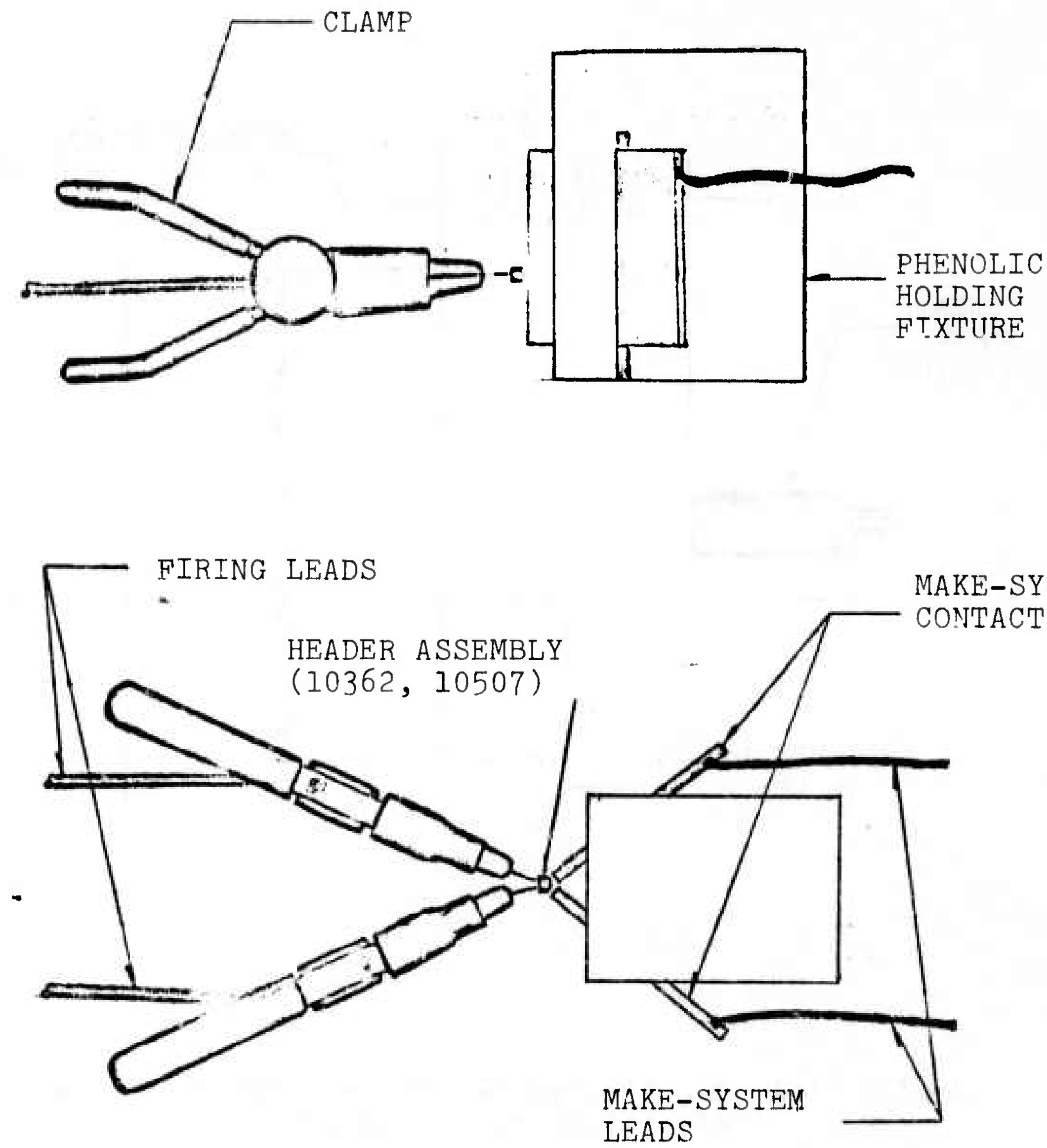
HEADER ASSEMBLY

10507

APPENDIX B

Figures

Tables

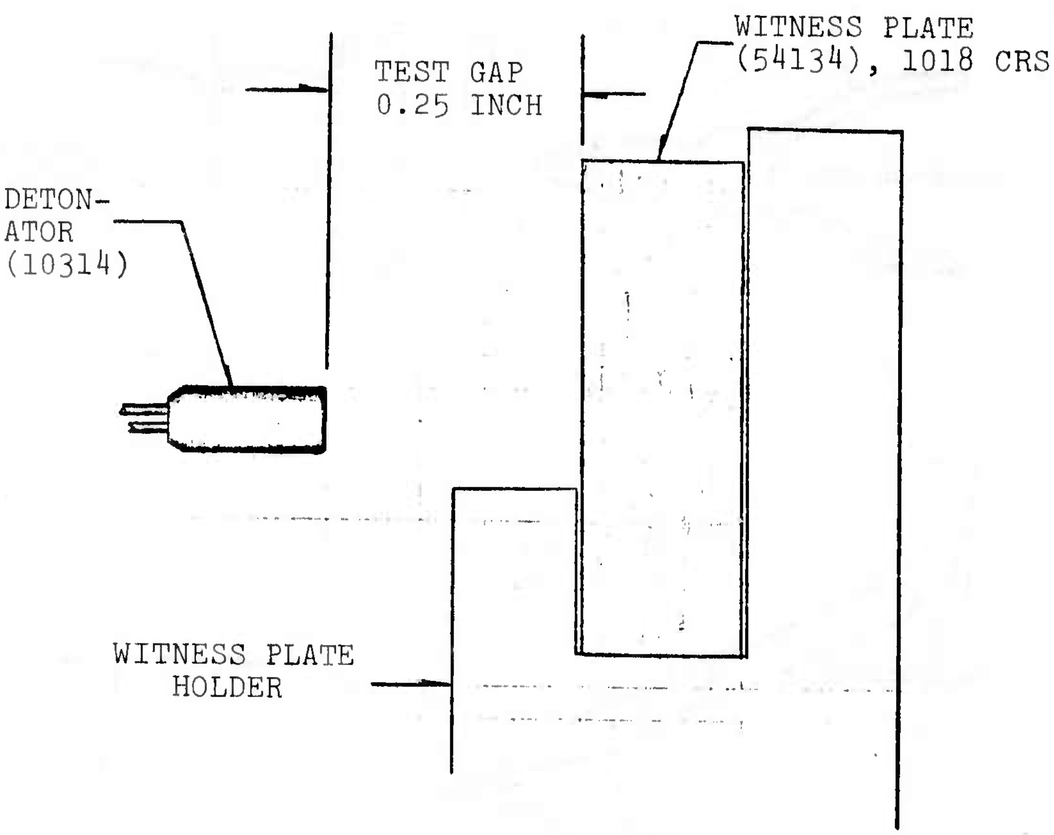


NOTES: (1) For Function Time Test, see Figure B-7 or electrical system hookup.

(2) For No-Fire Test, connect the firing leads to the constant current source (06258) and disconnect the make system.

Header Assembly Function Time and No-Fire Test Setup

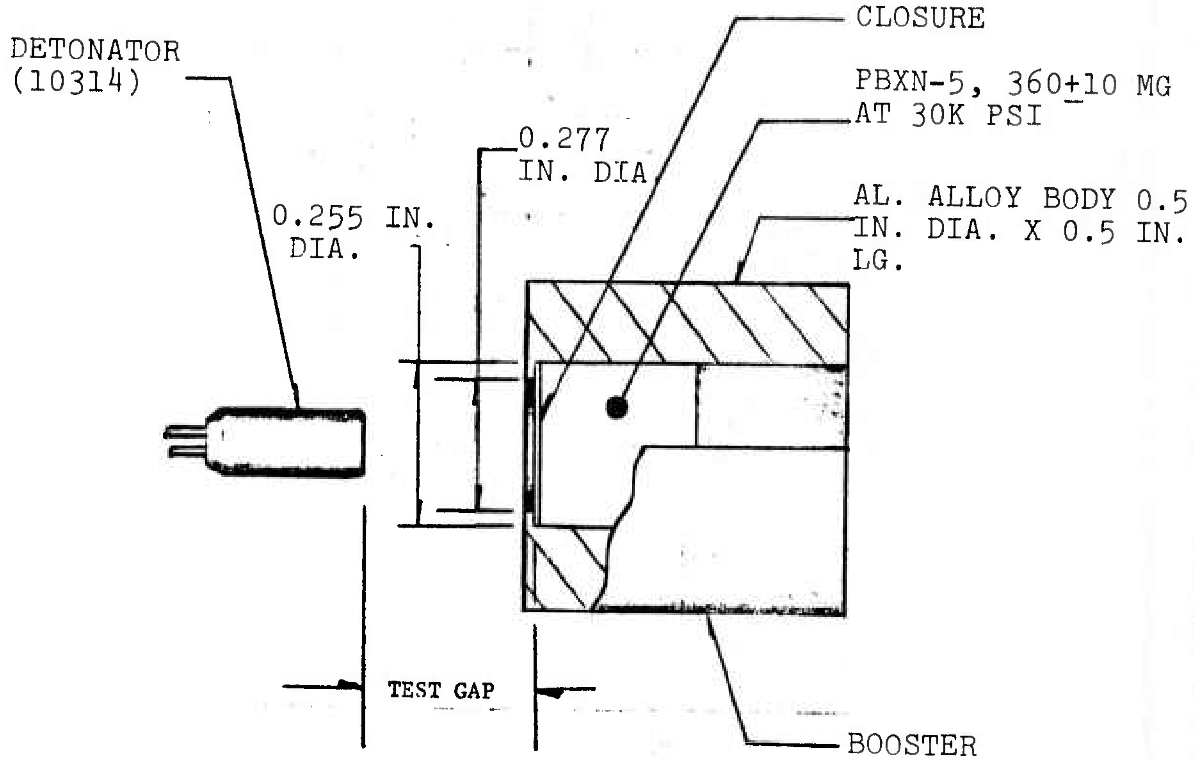
Figure B-1



NOTES: (1) See Figures B-6 and B-7 for detonator and electrical system hookup.

Detonator Dent Output Test Setup

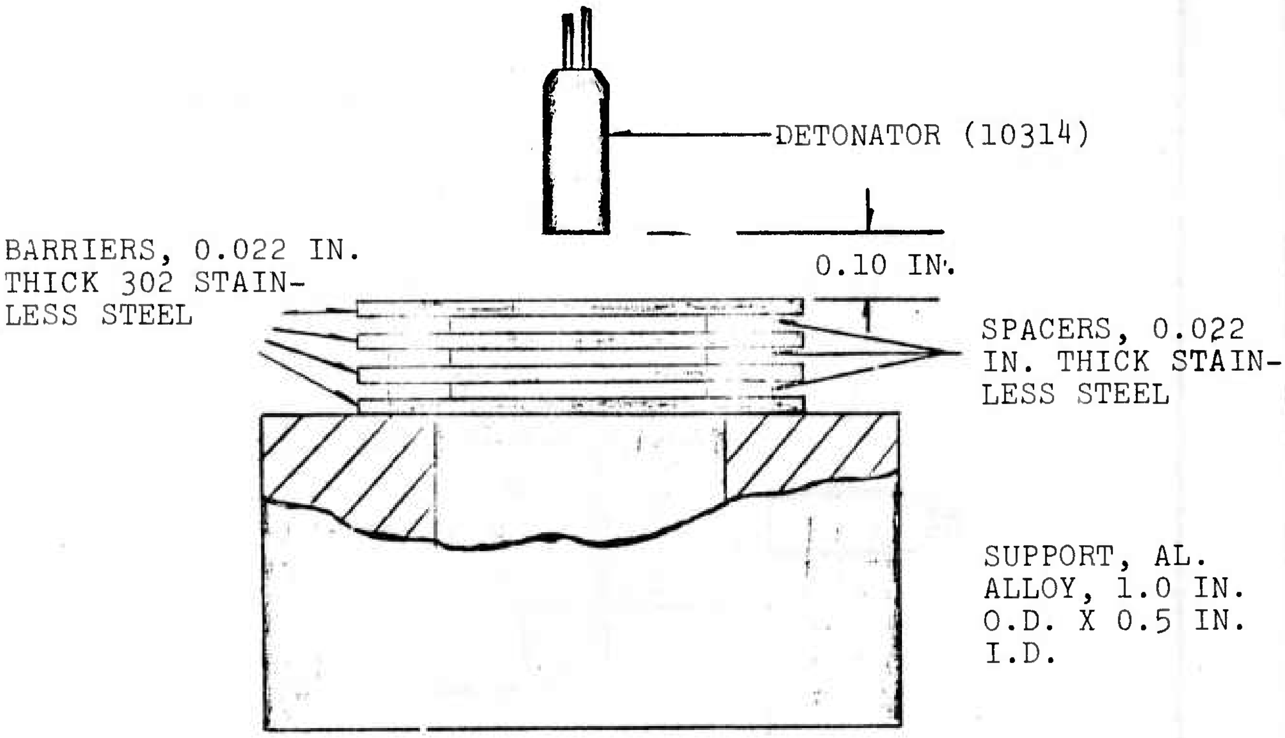
Figure B-2



NOTES: (1) See Figures B-6 and B-7 for detonator and electrical system hookup.

Detonator "Gap" and Booster Initiation Test Setup

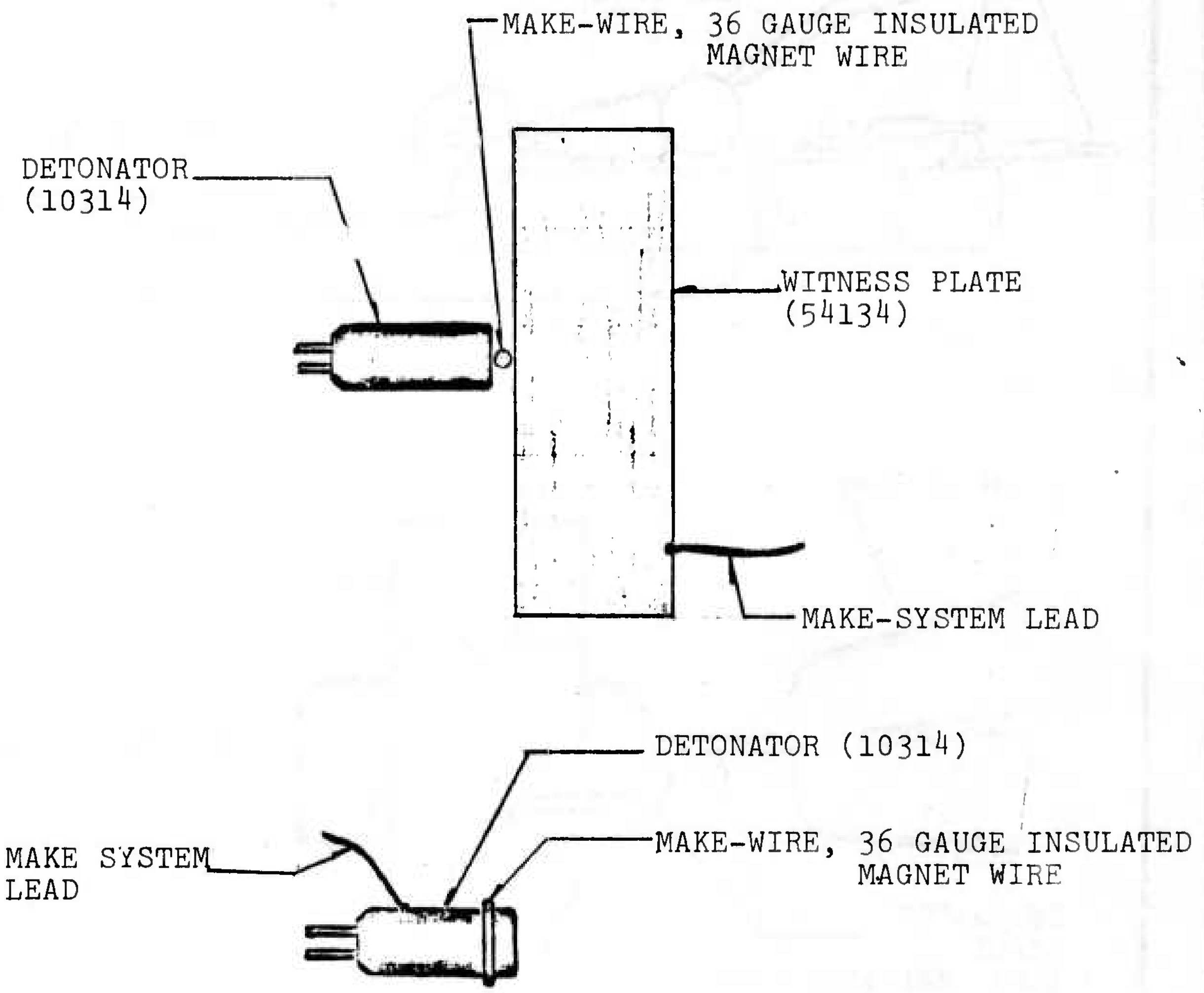
Figure B-3



NOTES: (1) See Figures B-6 and B-7 for detonator and electrical system hookup.

Steel Barrier Test Setup

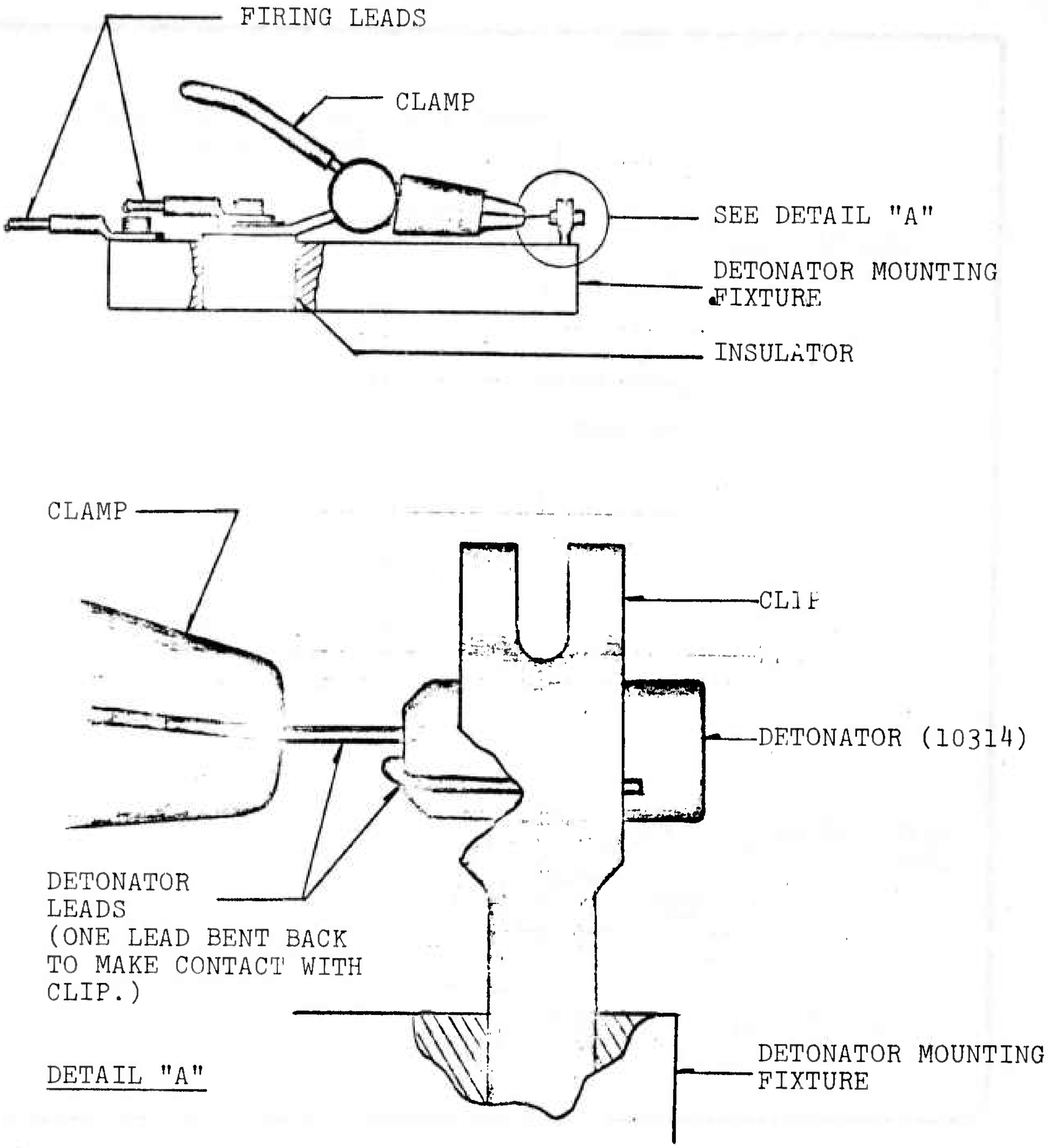
Figure B-4



NOTES: (1) See Figures B-6 and B-7 for detonator and electrical system hookup.

Detonator Make System Test Setup

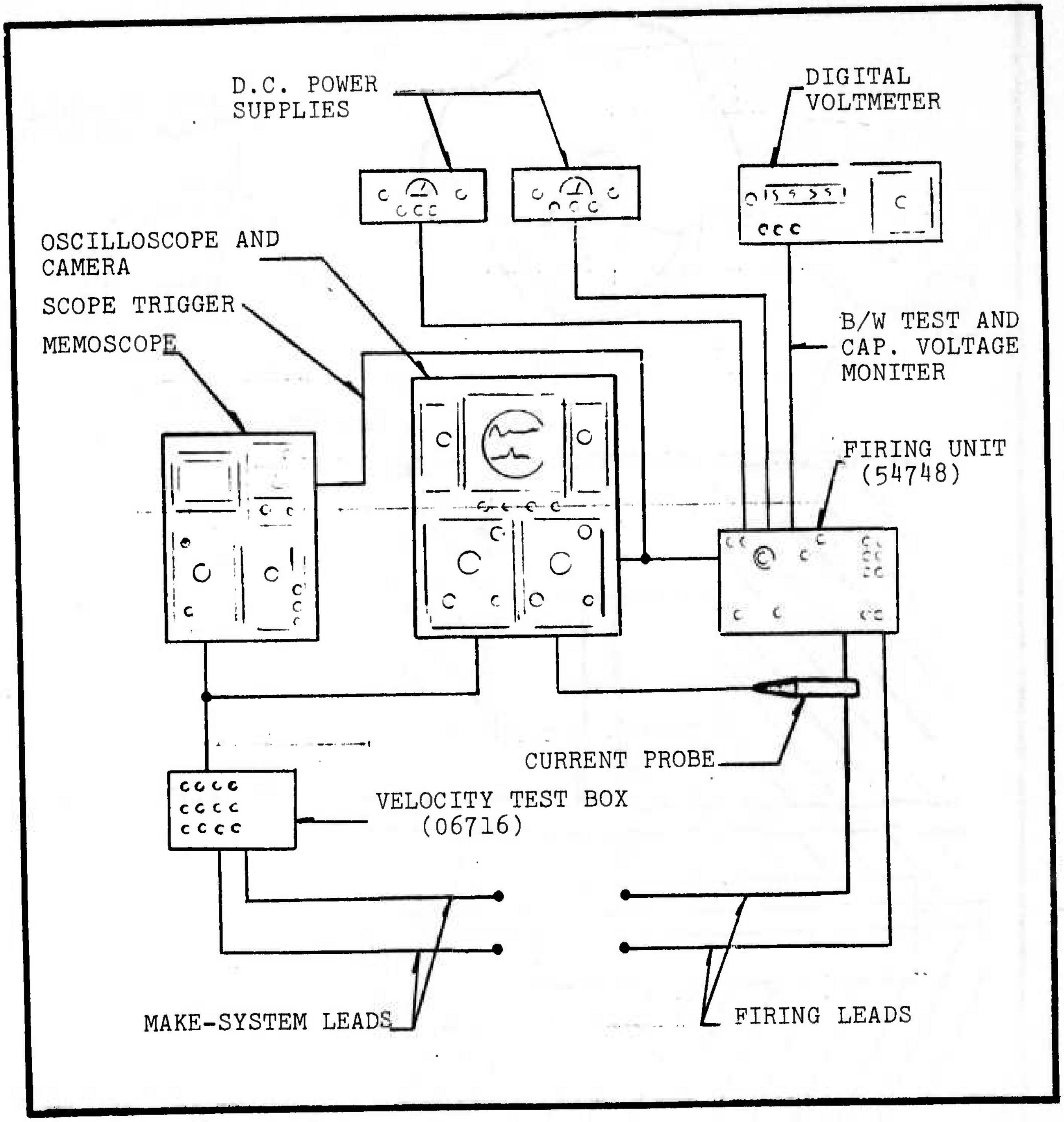
Figure B-5



NOTES: (1) See Figures B-6 and B-7 for detonator and electrical system hookup.

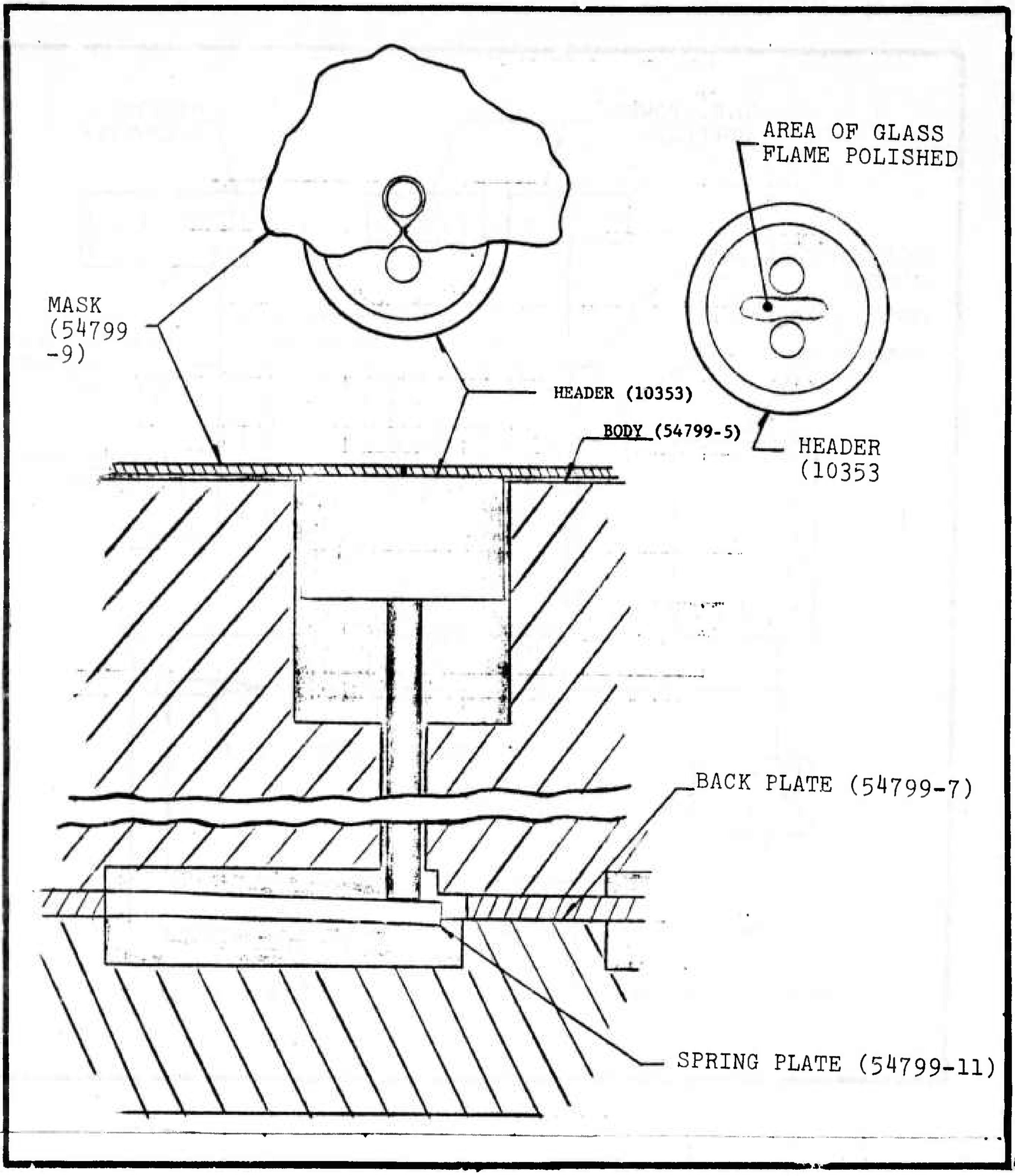
Detonator Make System Test Setup

Figure B-6



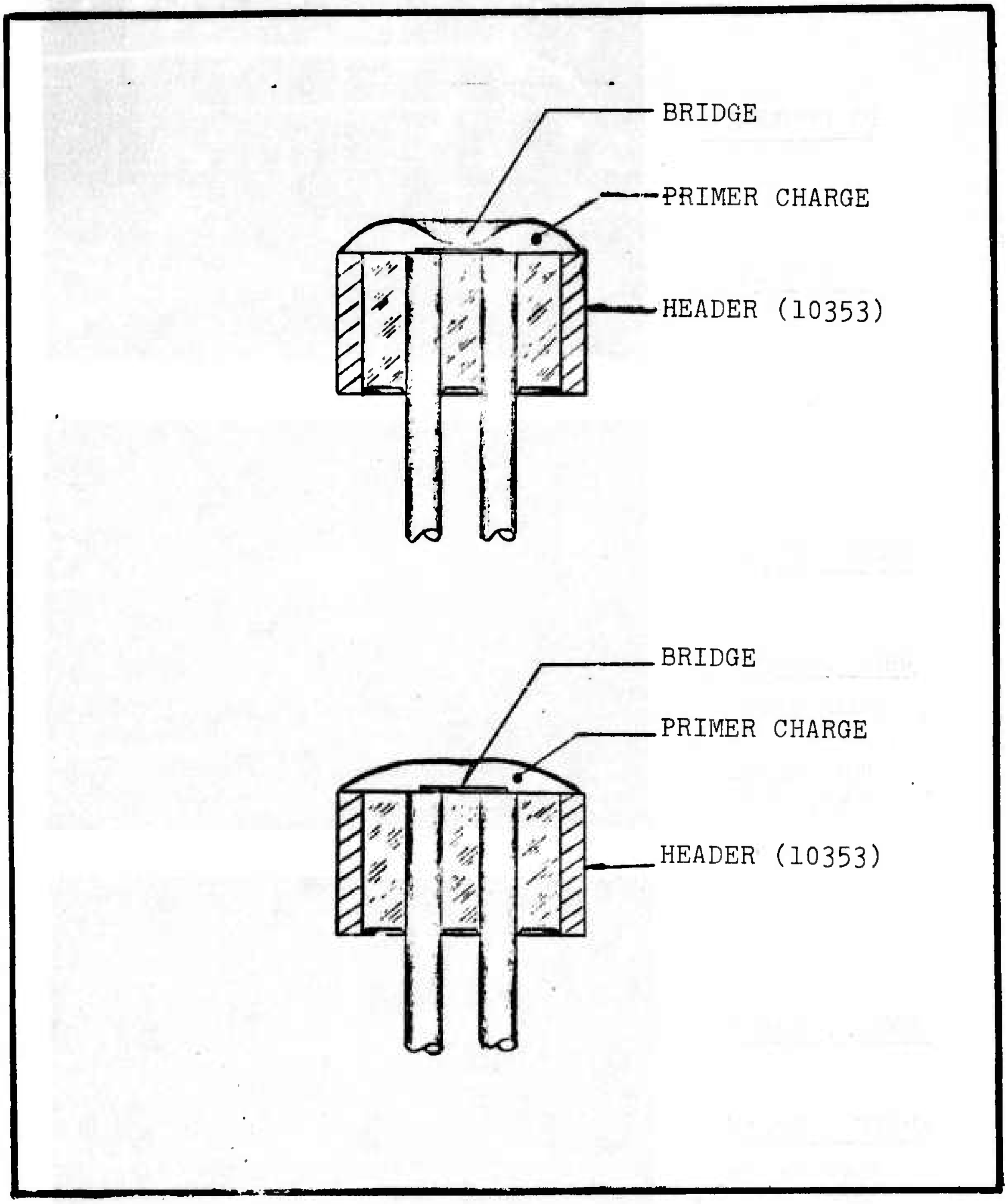
Electrical System Schematic

Figure B-7



Vapor Deposition Setup

Figure B-8



Header Assembly

Figure B-9

DB CURRENT

WB CURRENT

A

DBHA CURRENT

WBHA CURRENT

DBHA MAKE-
SYS. OUT.

WBH MAKE-
SYS. OUT.

B

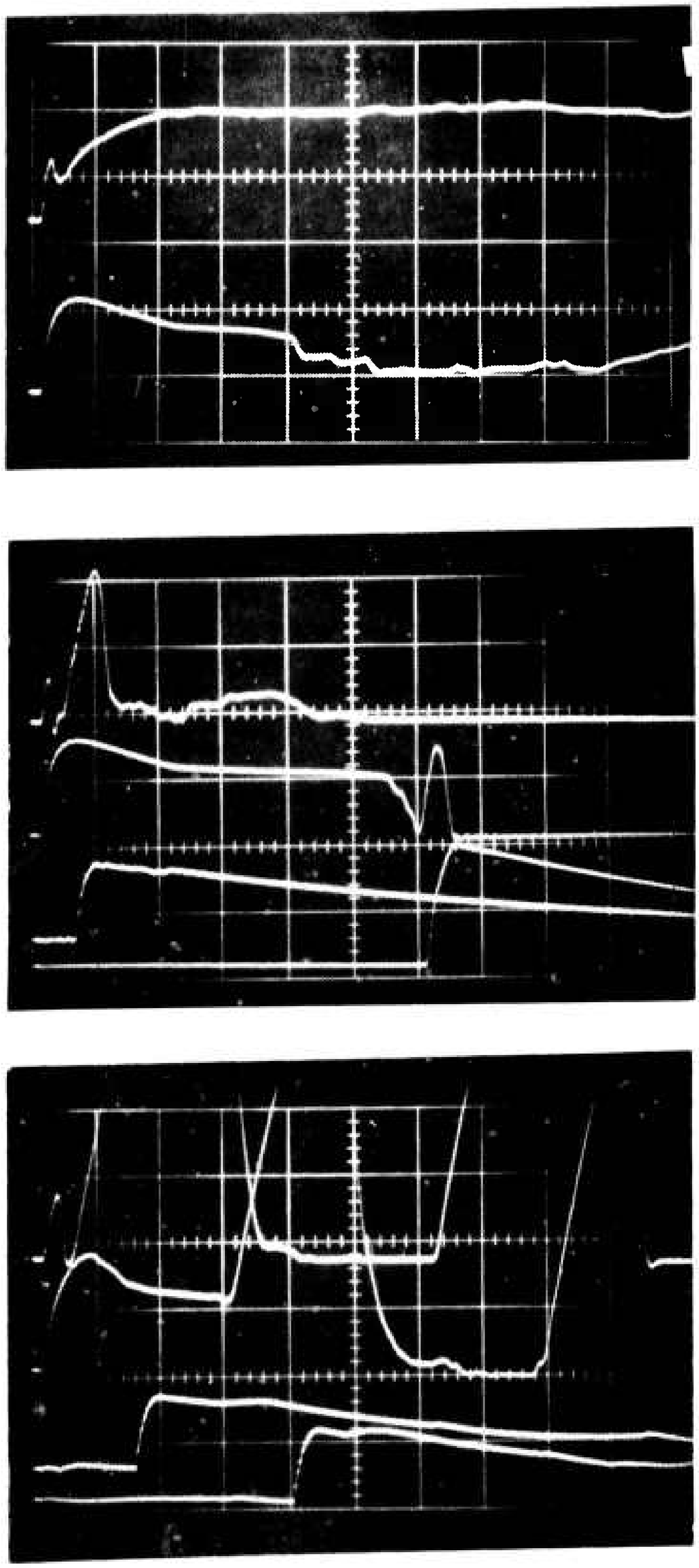
DBMPD CURRENT

WBMPD CURRENT

DBMPD MAKE-
SYS. OUT.

WBMPD MAKE-
SYS. OUT.

C



For all traces
Sweep rate:
1 Usec/cm

Oscillograph Records

Figure B-10

TABLE B-1
DEPOSITED BRIDGE RESISTANCE VERSUS LOCATION ON FIXTURE - RUN NO. 1

RUN NO. 1			Cr THICK. 200 A			pd THICK 4000 A			OHM/SQUARE .78				CRN 4264		P/N 10506		DATE 4-4-74		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	4.96								7.30	5.50	12.82									5.44
2		4.63	4.24						4.76	3.95	4.38							4.69	4.75	
3		4.78	5.55	5.56					4.33	4.22	5.03							4.92	6.20	
4				4.19	4.02	4.01	4.21	3.68	4.16	4.77	5.45	4.66	4.31	4.65	5.41	4.38	4.36			
5				3.81	4.70	3.94	3.58	3.66	3.65	4.17	3.58	4.13	3.99	3.70	4.40	3.81	4.46			
6				4.54	3.29	3.33	3.48	3.65	3.68	4.58	3.68	4.83	4.12	4.22	3.79	3.51	4.37			
7				3.79	3.95	8.37	4.46	4.88	3.80	4.23	4.12	4.22	3.75	3.75	3.64	2.71	4.09			
8			4.58	3.97	3.68	3.43	3.17	3.09	3.83	3.84	3.49	3.32	4.15	3.65	4.08	3.63	3.64			
9	3.25	4.61	3.48	3.55	3.20	3.15	3.09	2.98	2.70	3.55	6.11	3.20	3.16	3.58	3.71	3.27	3.61	2.98	3.48	3.73
10	2.92	3.97	3.37	8.33	4.96	3.01	3.44	2.66	3.45			3.33	3.06	3.30	2.45	3.14	3.25	4.49	3.35	3.16
11	4.05	3.01	3.86	4.00	3.50	3.15	2.89	3.47	3.17			3.56	3.25	3.02	OPEN	3.33	3.08	3.00	3.13	3.05
12			3.28	4.06	4.23	3.17	3.02	2.88	3.50	3.21	3.55	3.66	3.27	2.92	3.06	4.02	2.32	3.18		
13				3.25	3.01	2.90	3.05	2.46	3.25	2.75	2.81	2.89	2.79	2.92	2.60	2.46	2.58			
14				2.98	2.78	2.89	2.88	2.72	2.85	2.75	2.97	2.99	2.55	2.84	2.52	2.66	2.68			
15				2.85	2.49	2.77	3.20	2.98	3.40	2.98	2.82		3.18	2.66	4.32	2.85	3.75			
16				3.95	6.85	2.70	2.73	2.65	2.69	2.84	2.79	3.13	2.76	3.34	2.76	3.03	3.80			
17				2.82	3.34	2.83	2.76	2.93	2.60	2.72	2.89	2.54	3.62 TIGHT	3.36	2.72	3.15	2.72	2.20		
18			2.94	3.07	3.09		2.66	2.80	2.88	2.71	2.82	2.63	3.01	2.50 TIGHT	2.64 DOWN	2.98	2.74	2.99	3.14	
19		3.40	4.08	3.62						2.75	3.10	3.44						2.84 DOWN	3.13 DOWN	
20	5.35									3.08	3.25	3.47								

TABLE B-2
DEPOSITED BRIDGE RESISTANCE VERSUS LOCATION ON FIXTURE - RUN NO. 2

RUN NO. 2	Cr THICK 200 A				pd THICK 4300 A				OHM/SQUARE .72				CRN 4264		P/N 10506			DATE 4-11-74		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	5.24	6.79	5.03	5.14	4.03	6.22	5.10	4.85	5.21	5.91	5.74	6.55	6.09	9.00	7.24	6.21	5.56	5.64	7.09	OPEN
2	3.43	5.53	4.42	5.10	4.32	4.43	5.34	4.84	5.33	4.26	5.05	5.35	6.68	5.81	5.46	5.04	5.56	5.14	4.84	5.42
3	5.28	4.53	OPEN	5.55	4.52	4.30	5.43	5.18	4.80	9.00	5.62	5.57	5.99	6.96	3.94	4.71	4.33	6.28	8.45	9.06
4	3.17	4.41	3.82	3.88	4.22	4.31	4.00	4.35	4.12	4.78	6.00	4.72	4.58	5.15	5.74	3.97	1522	4.36	4.84	5.11
5	3.86	3.30	4.32	4.43	4.30	3.75	4.43	3.79	3.69	3.98	4.00	4.85	3.80	4.03	4.83	3.60	4.56	3.88	4.10	4.53
6	3.93	4.10	3.28	4.14	3.45	3.87	3.84	4.22	7.99	3.92	4.43	4.90	4.73	4.56	3.49	3.30	4.68	9.51	3.63	4.50
7	3.90	1484	9.45	4.20	3.54	3.74	3.57	3.77	4.08	3.69	4.67	4.27	4.27	4.00	4.02	5.17	4.73	4.25	4.23	6.16
8	3.46	3.82	OPEN	3.70	4.80	3.24	3.57	3.72	3.65	4.20	3.58	4.16	4.25	4.21	4.07	3.57	4.15	3.84	3.87	3.69
9	3.21	3.44	3.86	2.86	4.47	3.95	3.33	3.46	3.17	3.68	3.47	3.35	3.56	3.75	3.57	3.29	3.45	3.32	3.63	3.86
10	3.75	3.09	3.68	3.60	3.30	3.53	2.99	3.30	3.50			3.83	3.76	3.53	3.17	3.59	3.40	3.59	4.20	3.38
11	3.14	3.58	3.95	3.67	3.46	3.27	3.65	3.03	3.38			3.81	3.70	3.61	3.27	3.14	3.45	3.55	3.47	3.44
12	3.25	6.20	3.36	3.25	3.38	3.00	3.45	3.03	3.03	3.44	2.92	3.07	2.95	2.77	3.52	2.92	3.05	3.18	3.20	3.36
13	3.40	3.27	2.90	2.90	3.43	6.57	2.89	2.97	4.60	5.71	3.00	2.83	3.54	3.17	2.72	3.09	3.00	3.69	2.79	3.17
14	6.16	3.41	3.11	6.12	3.16	3.35	3.06	3.34	3.89	3.05	3.05	2.92	2.90	2.78	2.72	3.70	2.99	2.86	3.09	3.08
15	3.56	6.47	3.15	3.10	2.95	2.80	3.25	5.97	3.33	2.74	3.03	3.22	2.87	3.15	2.90	3.04	2.76	2.90	3.18	3.26
16	3.72	3.27	3.13	3.28	3.28	3.08	3.04	3.51	2.78	2.89	2.70	2.84	2.77	3.10	3.28	2.88	2.76	3.57	3.25	2.98
17	3.14	3.60	2.98	3.06	3.13	2.94	3.21	2.97	2.78	2.76	2.86	2.82	2.72	3.10	2.77	2.88	2.69	2.91	3.05	3.30
18	3.44	4.07	2.76	3.33	3.21	3.23	3.78	3.45	3.10	2.72	2.72	3.09	2.80	2.95	3.01	2.90	2.66	2.83	2.98	3.36
19	4.78	3.37	3.13	3.17	3.06	4.65	3.40	3.33	9.60	3.05	3.06	2.63	3.44	2.87	4.23	3.15	3.60	2.88	2.90	2.86
20	5.58	4.47	3.92	3.29	3.56	3.09	2160	4.02	2.91	3.44	3.00	3.19	3.25	3.91	3.52	3.23	3.71	3.66	3.10	2.90

TABLE B-3

DEPOSITED BRIDGE RESISTANCE VERSUS LOCATION ON FIXTURE - RUN NO. 3

RUN NO. 3				Cr THICK. 200 A			pd THICK. 4800 A				OHM/SQUARE .65			CRN 4264		P/N 10506		DATE 4-23-74		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	3.10	3.26	3.27	3.49	3.17	OPEN	3.70	5.02	3.47	3.79	3.92	4.70	4.50	6.36	7.80	4.87	3.63	4.23	4.05	3.91
2	3.54	3.75	2.07	3.19	2.94	3.21	3.21	4.11	3.56	2.87	4.93	3.80	5.62	6.32	3.35	3.74	4.30	3.74	4.12	4.31
3	2.69	2.47	2.34	3.47	2.88	2.70	3.71	3.46	3.12	3.65	4.00	3.96	4.05	5.22	3.17	9.73	3.19	3.59	3.97	3.92
4	2.64	2.77	2.65	2.93	2.72	2.51	2.51	2.56	2.82	3.35	3.61	3.28	1.93	4.06	3.54	3.20	3.21	3.45	3.11	3.20
5	2.38	2.48	2.42	2.65	2.52	2.46	2.20	2.67	2.37	2.72	2.39	5.41	2.42	3.00	2.94	2.78	2.53	2.82	2.72	4.60
6	2.40	OPEN	2.42	2.19	2.22	2.41	2.44	2.20	2.40	2.54	2.66	3.52	1411	2.98	2.66	3.03	2.03	2.12	2.63	3.00
7	2.82	2.72	2.30	2.98	2.16	2.45	2.50	2.99	3.26	2.96	2.91	3.34	3.03	2.50	3.43	2.42	1.97	2.70	2.47	2.56
8	2.31	2.38	2.27	2.27	2.69	2.11	2.66	2.10	2.75	2.51	2.10	2.26	2.74	3.22	2.77	2.61	2.76	2.98	2.76	2.72
9	2.04	2.45	2.51	2.47	2.20	1.64	2.03	2.34	2.30	2.13	2.21	3.29	2.42	2.29	2.75	2.27	2.28	2.44	2.34	2.53
10	3.46	2.03	2.18	2.26	2.58	2.24	1.98	2.36	2.27	EMP.	EMP.	2.44	2.31	2.78	2.22	2.18	2.22	2.53	1.85	2.14
11	2.24	2.45	2.33	2.45	2.22	2.27	2.32	2.27	2.64	EMP.	EMP.	2.48	2.35	2.36	1.97	1.97	2.25	2.17	2.16	2.08
12	2.70	2.25	2.56	2.36	2.70	2.00	2.03	2.30	2.23	2.66	3.75	2.07	2.00	2.00	2.06	2.27	1.95	1.98	2.11	3.47
13	2.19	2.06	2.02	2.33	2.03	1.75	2.68	1.93	1.90	1.75	2.00	1.84	1.95	2.04	1.87	2.00	2.46	2.00	1.61	2.62
14	1.93	2.17	2.06	2.44	2.07	2.00	2.14	2.06	1.77	1.94	1.83	2.34	1.63	OPEN	1.83	1.90	1.80	OPEN	1.84	2.40
15	2.08	2.08	2.27	2.19	2.02	1.99	2.00	2.50	2.13		2.20	2.32	2.09	2.27	2.03	OPEN	1.93	1.99	2.06	2.10
16	2.30	2.34	2.07	1.97	2.13	1.94	1.84	2.10	2.09	1.97	2.13	2.02	1.94	1.93	2.07	2.06	1.95	1.59	2.75	2.37
17	2.36	2.12	2.38	2.05	2.12	1.93	2.20	2.08	1.88	1.90	2.04	1.66	1.65	2.16	2.25	2.26	1.80	1.91	1.89	2.49
18	2.10	2.17	2.34	2.23	2.79	2.15	3.10	1.84	1.92	2.07	1.98	1.98	1.90	1.82	2.05	1.97	2.11	3.64	1.96	1.37
19	2.82	2.99	2.24	2.45	2.30	2.18	2.10	2.37	2.20	1.90	2.02	2.52	2.18	2.42	2.11	2.30	1.91	2.07	2.65	2.26
20	3.60	2.78	2.97	3.67	2.18	2.01	2.18	3.02	2.66	1.64	2.16	2.35	2.23	2.44	2.47	2.52	OPEN	2.39	2.10	2.32

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APPENDIX C

TEST DATA TABLES

TABLE C-1

MPD OUTPUT DATA SUMMARY

MPD, P/N 10314

ENVIRON-MENT	TEST GAP (IN)	NO. OF TEST	MPD OUTPUT DENT			BOOSTER INITIATION			RESULTS APPEAR ON DATA SHEETS
			AVE. (IN)	MIN. (IN)	MAX. (IN)	CLOSURE TYPE	CLOSURE THICK (IN)	NO. OF TRANSFER	
T&H	0.250	23	0.037	0.023	0.046				1,2,3,19,20
SHOCK	0.250	14	0.035	0.030	0.042				4 & 22
NO ENVIRONMENTS	0.250	36	0.035	0.028	0.046				5, 6, & 23
	0.250	2				AL	0.005	0	7 & 8
	0.150	4				AL	0.005	0	
	0.125	6				AL	0.005	2	
	0.100	7				AL	0.005	6	
	0.075	1				AL	0.005	1	
	0.075	2				AL	0.025	0	8 & 24
	0.075	7				AL	0.020	4	
	0.075	6				AL	0.016	3	
	0.075	5				AL	0.010	4	
	0.075	3				S.S.	0.022	0	8 & 25
	0.075	3				S.S.	0.015	4	
	0.075	7				S.S.	0.010	6	
	0.075	1				S.S.	0.005	1	

NOTE:

AL = Aluminum Closure

S.S. = Stainless Steel Closure

TABLE C-2

MPD FUNCTION TEST DATA SUMMARY

PART	P/N	ENV.	CAP (μFD)	CAP VOLT (VOLT)	FUNCTION: NO. OF TEST	FUNCTION: NO. FUNC	FUNCTION TIMES: TIME RANGE WITHIN ± 1 μSEC TOLER.	FUNCTION TIMES: NO. IN SPEC	FUNCTION TIMES: TIMES OUT OF SPEC.	FUNCTION TIMES: RESULTS APPEAR ON DATA SHEETS
HDR. ASSY	10362		1.0	5	5	0				9
				20	10	1	5.6			9
				30	10	9	5.1, 6.8, 9.6, 220, 240, 290, 315, 390, 440			10
				40	10	10	10.5,11.1, 12.2,12.5, 13.8,13.9, 14.1,14.4, 15.4			10, 11
			4.7	5	5	0				11
				20	10	10	7.0,17.0, 18.0,19.5, 21.0,22.5, 23.5,24.0, 26.0			11, 12
				30	10	10	7.0-8.8	9	9.1	12
				40	10	10	4.2-5.1	9	6.3	13
			22	5	5	5	35.5,37.5, 40.5,40.5, 41.5			13

NOTE: (1) MPD are not solder sealed

TABLE C-2

MPD FUNCTION TEST DATA SUMMARY — Continued

PART	P/N	ENV.	CAP (μFD)	CAP VOLT (VOLT)	FUNCTION: NO. OF TEST	FUNCTION: NO. FUNC	FUNCTION TIMES: TIME RANGE WITHIN ± 1 μSEC TOLER.	FUNCTION TIMES: NO. IN SPEC	FUNCTION TIMES: TIMES OUT OF SPEC.	RESULTS APPEAR ON DATA SHEETS
HDR ASSY	10362		22	20	10	9	1.5,10.6, 11.1,11.6, 12.2,13.6, 15.6,16.4, 16.8			14
				30	10	10	5.5-7.2	10		14, 15
				40	10	10	3.9-4.1	10		15
HDR. ASSY	10507		1.0	5	5	0				27
				10	5	0				27
				20	10	0				27, 28
				30	20	10	0.5-0.9	10		28, 29
				40	20	17	0.4-0.9	10		29, 30
			4.7	5	5	0				31
				10	5	0				31
				20	10	3	0.8-1.0	3		31, 32
				30	20	14	0.5-0.7	14		32, 33
				40	20	19	0.45-0.7	19		33, 34
			22	5	5	0				35
				10	10	0				35
				20	10	4	0.7-1.0	4		35, 36
				30	20	14	0.5-0.7	14		36, 37
				40	37	37	0.3-0.6	37		37, 38, 39, 40, 41
			147	30	15	14	0.4-0.6	14		39, 40

NOTES: (1) MPD are not solder sealed

TABLE C-2

MPD FUNCTION TEST DATA SUMMARY — Concluded

PART	P/N	ENV.	CAP (μFD)	CAP VOLT (VOLT)	FUNCTION: NO. OF TEST	FUNCTION: NO. FUNC	FUNCTION TIMES: TIME RANGE WITHIN ± 1 μSEC TOLER.	FUNCTION TIMES: NO. IN SPEC	FUNCTION TIMES: TIMES OUT OF SPEC.	RESULTS APPEAR ON DATA SHEETS
WBMPD	10314-101	T&H	22	30	18	15	5.4-7.1	10	7.5, 7.9, 9.4, 9.6, 10.6	1, 2, 3
		SHOCK	22	30	15	10	5.9-7.6	5	8.8, 9.0, 16.8, >20, >20	4
			22	30	9	9	6.6-8.6	6	9.1, 9.4, 23.0	6
WBMPD	10314-101 (1)		22	30	44	44	6.0-8.0	32	2.4, 2.6, 2.7, 3.0, 5.2, 5.3, 5.5, 5.8, 8.1, 8.1, 8.4, 22.0	5, 7, 8
DBMPD	10314-103	T&H	22	40	23	13	1.3-1.6	13		19, 20, 21
		SHOCK	22	40	15	4	1.3-1.6	4		22
			22	40	33	25	1.1-1.5	25		23, 24(374-377), 25(389-392), 26
DBMPD	10314-103 (1)		22	40	22	22	1.1-1.3	22		24(363-373), 25(378-388)

NOTES: (1) MPD are not solder sealed

TABLE C-3

TEST DATA RECORDS

Sheet 1

DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10314-101
PART NAME MINIATURE PRECISION DETONATOR	4264	ENVIRONMENT - T&H
4-22-74	5-28-74	70°F
52%		

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)	B/W (2) (OHM)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (μSEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
1	4.46				4.92				SEE NOTE 3			
2	4.17	C	22	30.0	4.15	0.25			YES	6.3	0.040	
3	4.24				4.14				SEE NOTE 3			
4	4.49				3.08				SEE NOTE 3			
5	4.21								SEE NOTE 3			
6	4.31								SEE NOTE 3			
7	4.21	C	22	30.0	4.19	0.25			NO			
8	4.20	C	22	30.0	4.17	0.25			YES	7.9	0.039	
9	4.33	C	22	30.0	4.32	0.25			YES	6.2	0.046	
10	4.28								SEE NOTE 3			
11	4.61				4.37				SEE NOTE 3			
12	4.28	C	22	30.0	4.28	0.25			YES	9.6	0.034	
13	4.46								SEE NOTE 3			
14	4.25	C	22	30.0	4.24	0.25			YES	10.6	0.035	
15	4.46	C	22	30.0	4.43	0.25			YES	6.1	0.036	

NOTES:

(1) Test Configurations --
 A - Header Assembly Function Time Test (Figure B-1)
 B - Header Assembly "No-fire" Test (Figure B-1)
 C - Detonator Dent Output Test (Figure B-2)
 D - Detonator Gap Test (Figure B-3)
 E - Booster (Variable Closure) Initiation Test (Figure B-3)
 F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 2

DEVELOPMENT				SENSITIVITY/ FUNCTION TIME/OUTPUT				10314-101			
MINIATURE PRECISION DETONATOR						4264		ENVIRONMENT - T&H			
TEST START 4-22-74		TEST COMPLETE 5-28-74		AMB. TEMP. 70°F		REL. HUMIDITY 52 %					
SPECIMEN		TEST							TEST RESULTS		
									DETONATOR			
NO.	B/W (OHM)	TEST (1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)	B/W (2) (OHM)	TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
16	4.13	C	22	30.0	4.11	0.250			YES	6.4	0.036	
17	4.44				4.23				SEE NOTE 3			
18	4.29	C	22	30.0	4.14	0.250			YES	6.8	0.037	
19	4.31	C	22	30.0	4.16	0.250			NO			
20	4.07	C	22	30.0	3.92	0.250			YES	9.4	0.040	
21	4.44	C	22	30.0	4.28	0.250			YES	5.7	0.032	
22	4.35								SEE NOTE 3			
23	4.49	C	22	30.0	4.33	0.250			YES	7.1	0.033	
24	4.40				4.25				SEE NOTE 3			
25	4.55				4.38				SEE NOTE 3			
26	4.29	C	22	30.0	4.16	0.250			YES	7.5	0.040	
27	4.14	C	22	30.0	3.99	0.250			YES	5.4	0.035	
28	4.50	C	22	30.0	4.33	0.250			NO			
29	4.30	C	22	30.0	4.17	0.250			YES	6.5	0.036	
30	4.19								SEE NOTE 3			

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 3

DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT		10314-101
PART NAME MINIATURE PRECISION DETONATOR	LOT NO.	4264	PROCEDURE NUMBER & PARA. NO. ENVIRONMENT - T&H
TEST START 4-22-74	TEST COMPLETE 5-28-74	AMB. TEMP. 70°F	REL. HUMIDITY 52%	TEST EQUIPMENT NUMBERS

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)	(2) B/W (OHM)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
31	4.28	C	22	30.0	4.16	0.250			YES	6.8	0.036	
32	4.43				4.28				SEE NOTE 3			

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 4

DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10314-101
MINIATURE PRECISION DETONATOR	4264	ENVIRONMENT - SHOCK
TEST START 4-22-74 / TEST COMPLETE 5-28-74	AMB. TEMP. 70°F	REL. HUMIDITY 52 %

SPECIMEN		TEST					BOOSTER CLOSURE		TEST RESULTS DETONATOR			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)	(2) B/W (OHM)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
33	4.62	C	22	30.0	4.57	0.250			YES	9.0	0.037	
34	4.20	C	22	30.0	4.18	0.250			YES	16.8	0.034	
35	4.11	C	22	30.0	4.10	0.250			NO			
36	4.51	C	22	30.0	4.48	0.250			YES	8.8	0.032	
37	4.55	C	22	30.0	4.53	0.250			YES	7.3	0.031	
38	4.47	C	22	30.0	4.42	0.250			NO			
39	4.38	C	22	30.0	4.34	0.250			YES	7.6	0.030	
40	4.47	C	22	30.0	4.43	0.250			YES	5.9	[illegible]	
41	4.39	C	22	30.0	4.37	0.250			YES	>20.0	0.038	
42	4.50	C	22	30.0	4.47	0.250			YES	6.5	0.030	
43	4.46	C	22	30.0	4.42	0.250			NO			
44	4.19	C	22	30.0	4.15	0.250			YES	>20.0	0.035	
45	4.30	C	22	30.0	4.26	0.250			NO			
46	4.46	C	22	30.0	4.45	0.250			NO			
47	4.29	C	22	30.0	4.27	0.250			YES	7.0	0.037	

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 5

DEVELOPMENT		SENSITIVITY/ FUNCTION TIME/OUTPUT		10314-101
MINIATURE PRECISION DETONATOR			4264	
5-14-74	5-28-74	70 °F	50 %	

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (MSEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
48	4.08	C	22	30.0		0.250			YES	6.5	0.031	
49	4.02	C	22	30.0		0.250			YES	7.2	0.032	
50	4.39	C	22	30.0		0.250			YES	6.4	0.039	
51	3.90	C	22	30.0		0.250			YES	6.0	0.036	
52	4.26	C	22	30.0		0.250			YES	8.0	0.035	
53	4.29	C	22	30.0		0.250			YES	6.1	0.034	
54	4.03	C	22	30.0		0.250			YES	6.3	0.044	
55	4.29	C	22	30.0		0.250			YES	7.6	0.040	
56	4.19	C	22	30.0		0.250			YES	7.2	0.029	
57	4.29	C	22	30.0		0.250			YES	6.0	0.032	
58	4.12	C	22	30.0		0.250			YES	6.8	0.038	
59	4.04	C	22	30.0		0.250			YES	6.2	0.034	
60	4.13	C	22	30.0		0.250			YES	7.6	0.042	
61	4.06	C	22	30.0		0.250			YES	7.1	0.035	
62	4.03	C	22	30.0		0.250			YES	6.6	0.036	

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 6

TYPE OF TEST: DEVELOPMENT		PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT		PART NUMBER: 10314-101
PART NAME: MINIATURE PRECISION DETONATOR		LOT NO.	TEST SET / CRN: 4264	PROCEDURE NUMBER & PARA. NO.
TEST START: 5-15-74	TEST COMPLETE: 5-28-74	AMB. TEMP.: 70°F	REL. HUMIDITY: 50%	TESTED/WITNESSED BY

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST CONFIC. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (μSEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
63	4.30	C	22	30.0		0.250			YES	6.6	0.044	
64	4.44	C	22	30.0		0.250			YES	9.4	0.037	
65	4.19	C	22	30.0		0.250			YES	23.0	0.032	
66	4.19	C	22	30.0		0.250			YES	6.9	0.038	
67	4.54	C	22	30.0		0.250			YES	7.3	0.036	
68	4.20	C	22	30.0		0.250			YES	9.1	0.028	
69	4.31	C	22	30.0		0.250			YES	6.9	0.031	
70	4.23	C	22	30.0		0.250			YES	6.7	0.045	
71	4.52	C	22	30.0		0.250			YES	8.6	0.033	

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 7

TYPE OF TEST: DEVELOPMENT			PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT					PART NUMBER: 10314-101				
PART NAME: MINIATURE PRECISION DETONATOR						RN: 4264		PROCEDURE NUMBER & PARA.				
TEST START: 5-16-74		TEST COMPLETE: 5-28-74		AMB. TEMP.: 71°F		REL. HUMIDITY: 50%						
SPECIMEN		TEST						TEST RESULTS				
								DETONATOR				
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME	DENT (IN)	BOOST. FUNC. (YES/NO)
72	4.16	D	22	30.0		0.25	AL	0.005	YES	5.5		NO
73	4.00	D	22	30.0		0.10	AL	0.005	YES	7.7		YES
74	4.28	D	22	30.0		0.25	AL	0.005	YES	2.6		NO
75	4.28	D	22	30.0		0.10	AL	0.005	YES	7.0		YES
76	4.52	D	22	30.0		0.15	AL	0.005	YES	8.1		NO
77	4.33	D	22	30.0		0.10	AL	0.005	YES	3.0		YES
78	4.25	D	22	30.0		0.15	AL	0.005	YES	6.5		NO
79	4.19	D	22	30.0		0.125	AL	0.005	YES	5.8		NO
80	4.05	D	22	30.0		0.10	AL	0.005	YES	6.8		YES
81	3.88	D	22	30.0		0.125	AL	0.005	YES	5.2		YES
82	4.55	D	22	30.0		0.15	AL	0.005	YES	22.0		NO
83	4.50	D	22	30.0		0.125	AL	0.005	YES	7.4		YES
84	4.47	D	22	30.0		0.15	AL	0.005	YES	8.4		NO
85	4.18	D	22	30.0		0.125	AL	0.005	YES	6.7		NO
86	4.16	D	22	30.0		0.10	AL	0.005	YES	2.7		YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 8

DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT		10314-101
MINIATURE PRECISION DETONATOR		4264	
TEST START 5-16-74	TEST COMPLETED 5-28-74	71°F	50%

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
87	4.24	D	22	30.0		0.125	AL	0.005	YES	6.7		NO
88	4.34	D	22	30.0		0.100	AL	0.005	YES	6.0		NO
89	3.93	D	22	30.0		0.075	AL	0.005	YES	6.5		YES
90	4.31	D	22	30.0		0.100	AL	0.005	YES	6.7		YES
91	4.76	D	22	30.0		0.125	AL	0.005	YES	7.0		NO
92	4.58	E	22	30.0		0.075	AL	0.010	YES	7.6		YES
93	4.28	E	22	30.0		0.075	AL	0.010	YES	7.0		YES
94	4.36	E	22	30.0		0.075	AL	0.010	YES	8.1		NO
95	4.23	E	22	30.0		0.075	AL	0.010	YES	5.3		YES
96	4.38	E	22	30.0		0.075	AL	0.010	YES	7.4		YES
97	4.41	E	22	30.0		0.075	SS	0.010	YES	6.8		YES
98	4.35	E	22	30.0		0.075	SS	0.010	YES	7.0		YES
99	4.36	E	22	30.0		0.075	SS	0.022	YES	7.4		NO
100	4.17	E	22	30.0		0.075	SS	0.022	YES	2.4		NO

NOTES:

(1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 9

TYPE OF TEST		PARAMETER	PART NUMBER
DEVELOPMENT		SENSITIVITY/ FUNCTION TIME/OUTPUT	10362
PART NAME MINIATURE PRECISION DETONATOR / HDR. ASSY.		LOT NO. / LOT SIZE / CRN 4264	PROCEDURE NUMBER & PARA. NO.
TEST START 5-3-74	TEST COMPLETE 5-28-74	AMB. TEMP. 70°F / REL. HUMIDITY 50%	TEST EQUIPMENT NUMBERS

SPECIMEN		TEST					BOOSTER CLOSURE		TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST(1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
111	3.98	A	1	5.0					No	–		No
112	4.26	A	1	5.0					No	–		No
113	4.30	A	1	5.0					No	–		No
114	4.55	A	1	5.0					No	–		No
115	4.25	A	1	5.0					No	–		No
116	4.43	A	1	20.0					No	–		No
117	4.20	A	1	20.0					No	–		No
118	4.18	A	1	20.0					No	–		No
119	4.15	A	1	20.0					No	–		No
120	4.31	A	1	20.0					No	–		No
121	4.10	A	1	20.0					No	–		No
122	4.16	A	1	20.0					No	–		No
123	4.24	A	1	20.0					No	–		No
124	4.01	A	1	20.0					YES	5.6		YES
125	4.29	A	1	20.0					No	–		No

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3
TEST DATA RECORDS

Sheet 10

TYPE OF TEST: DEVELOPMENT		PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT		PART NUMBER: 10362
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.		LOT NO.	LOT SIZE	SRN: 4264	PROCEDURE NUMBER & PARA. NO.
TEST START: 5-3-74	TEST COMPLETE: 5-28-74	AMB. TEMP.: 70°F	REL. HUMIDITY: 50%	TEST EQUIPMENT NUMBERS

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST(1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
126	4.45	A	1	30.0					YES	220		YES
127	4.20	A	1	30.0					YES	315		YES
128	4.06	A	1	30.0					YES	290		YES
129	4.09	A	1	30.0					NO	—		NO
130	4.40	A	1	30.0					YES	390		YES
131	4.46	A	1	30.0					YES	440		YES
132	4.37	A	1	30.0					YES	9.6		YES
133	4.30	A	1	30.0					YES	240		YES
134	4.52	A	1	30.0					YES	6.8		YES
135	4.36	A	1	30.0					YES	5.1		YES
136	4.32	A	1	40.0					YES	11.1		YES
137	4.28	A	1	40.0					YES	13.8		YES
138	4.53	A	1	40.0					YES	12.2		YES
139	4.24	A	1	40.0					YES	12.5		YES
140	4.36	A	1	40.0					YES	13.9		YES

NOTES:

(1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test
(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 11

TYPE OF TEST: DEVELOPMENT			PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT				PART NUMBER: 10362			
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.			LOT NO.	LOT SIZE	CRN: 4264		PROCEDURE NUMBER & PARA. NO.			
TEST START: 5-3-74		TEST COMPLETE: 5-28-74	AMB. TEMP.: 70°F		REL. HUMIDITY: 50%		TEST EQUIPMENT NUMBERS			

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
141	4.45	A	1	40.0					YES	15.4		YES
142	4.43	A	1	40.0					YES	13.7		YES
143	4.05	A	1	40.0					YES	10.5		YES
144	4.36	A	1	40.0					YES	14.4		YES
145	4.52	A	1	40.0					YES	14.1		YES
146	4.45	A	4.7	5.0					NO	–		NO
147	4.40	A	4.7	5.0					NO	–		NO
148	4.46	A	4.7	5.0					NO	–		NO
149	4.47	A	4.7	5.0					NO	–		NO
150	4.43	A	4.7	5.0					NO	–		NO
151	4.56	A	4.7	20.0					YES	24		YES
152	4.30	A	4.7	20.0					YES	21		YES
153	4.16	A	4.7	20.0					YES	19		YES
154	3.93	A	4.7	20.0					YES	18		YES
155	4.57	A	4.7	20.0					YES	17		YES

NOTES:

(1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 12

TYPE OF TEST	PARAMETER		A… NUMBER
DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT		10362

PART NAME	LOT NO.	LOT SIZE	CRN	PROCEDURE NUMBER & PARA. NO.
MINIATURE PRECISION DETONATOR / HDR ASSY			4264	

TEST START	TEST COMPLETE	AMB. TEMP.	REL. HUMIDITY	TEST EQUIPMENT NUMBERS
5-3-74	5-28-	70°F	50%	

SPECIMEN NO.	SPECIMEN B/W (OHM)	TEST TEST CONFIG.(1)	TEST CAP. (μFD)	TEST CAP. VOLT. (VOLT)	TEST	TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	TEST RESULTS SPECIMEN FUNC. (YES/NO)	FUNC. TIME (μSEC)	DENT (IN)	OPEN B/W (YES/NO)
156	4.53	A	4.7	20.0					YES	23.5		YES
157	4.54	A	4.7	20.0					YES	26		YES
158	4.40	A	4.7	20.0					YES	19.5		YES
159	4.29	A	4.7	20.0					YES	22.5		YES
160	4.42	A	4.7	20.0					YES	7		YES
161	4.28	A	4.7	30.0					YES	7.9		YES
162	4.25	A	4.7	30.0					YES	8.2		YES
163	4.23	A	4.7	30.0					YES	8		YES
164	4.24	A	4.7	30.0					YES	8.8		YES
165	4.05	A	4.7	30.0					YES	7		YES
166	4.35	A	4.7	30.0					YES	8.2		YES
167	4.54	A	4.7	30.0					YES	9.1		YES
168	4.38	A	4.7	30.0					YES	8.8		YES
169	4.49	A	4.7	30.0					YES	8.4		YES
170	4.41	A	4.7	30.0					YES	8.5		YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 13

TYPE OF TEST			PARAMETER				PART NUMBER			
DEVELOPMENT			SENSITIVITY/ FUNCTION TIME/OUTPUT				10362			
PART NAME MINIATURE PRECISION DETONATOR / HDR. ASSY.			LOT NO.	LOT SIZE	CRN 4264		PROCEDURE NUMBER & PARA. NO.			
TEST START 5-3-74	TEST COMPLETE 5-28-74		AMB. TEMP. 70°F		REL. HUMIDITY 50%		TEST EQUIPMENT NUMBERS			

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
							BOOSTER CLOSURE					
NO.	B/W (OHM)	TEST (1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
171	4.41	A	4.7	40.0					YES	4.2		YES
172	4.54	A	4.7	40.0					YES	4.6		YES
173	4.35	A	4.7	40.0					YES	4.6		YES
174	4.50	A	4.7	40.0					YES	4.8		YES
175	4.69	A	4.7	40.0					YES	5.1		YES
176	4.57	A	4.7	40.0					YES	6.3		YES
177	4.30	A	4.7	40.0					YES	4.7		YES
178	4.39	A	4.7	40.0					YES	4.6		YES
179	4.37	A	4.7	40.0					YES	4.8		YES
180	4.33	A	4.7	40.0					YES	4.7		YES
181	4.11	A	22	5.0					YES	40.5		YES
182	4.47	A	22	5.0					YES	40.5		YES
183	4.23	A	22	5.0					YES	35.0		YES
184	4.44	A	22	5.0					YES	37.5		YES
185	4.52	A	22	5.0					YES	41.5		YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 14

TYPE OF TEST	PARAMETER	PART NUMBER
DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10362

PART NAME	LOT NO.	LOT SIZE	CRN	PROCEDURE NUMBER & PARA. NO.
MINIATURE PRECISION DETONATOR / HDR. ASSY.			4264	

TEST START	TEST COMPLETE	AMB. TEMP.	REL. HUMIDITY	TEST EQUIPMENT NUMBERS
5-3-74	5-28-74	70°F	50%	

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST(1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
186	4.26	A	22	20.0					YES	10.6		YES
187	4.49	A	22	20.0					YES	1.5		YES
188	4.36	A	22	20.0					YES	13.6		YES
189	4.05	A	22	20.0					YES	12.2		YES
190	4.04	A	22	20.0					NO	—		YES
191	4.07	A	22	20.0					YES	11.6		YES
192	4.02	A	22	20.0					YES	11.1		YES
193	4.04	A	22	20.0					YES	16.4		YES
194	4.68	A	22	20.0					YES	16.8		YES
195	4.66	A	22	20.0					YES	15.6		YES
196	4.32	A	22	30.0					YES	6.0		YES
197	4.22	A	22	30.0					YES	5.5		YES
198	4.47	A	22	30.0					YES	6.4		YES
199	4.54	A	22	30.0					YES	6.2		YES
200	4.12	A	22	30.0					YES	5.5		YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 15

TYPE OF TEST: DEVELOPMENT			PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT						PART NUMBER: 10362			
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.			LOT NO.		LOT SIZE	CRN: 4264			PROCEDURE NUMBER & PARA. NO.			
TEST START: 5-3-74		TEST COMPLETE: 5-28-74		AMB. TEMP.: 70°F		REL. HUMIDITY: 50%			TEST EQUIPMENT NUMBERS			
SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
201	4.40	A	22	30.0					YES	5.9		YES
202	4.43	A	22	30.0					YES	6.1		YES
203	4.46	A	22	30.0					YES	7.2		YES
204	4.45	A	22	30.0					YES	6.7		YES
205	4.48	A	22	30.0					YES	5.9		YES
206	4.19	A	22	40.0					YES	3.9		YES
207	4.36	A	22	40.0					YES	3.9		YES
208	4.37	A	22	40.0					YES	4.1		YES
209	4.40	A	22	40.0					YES	3.9		YES
210	4.37	A	22	40.0					YES	4.0		YES
211	4.37	A	22	40.0					YES	3.9		YES
212	4.32	A	22	40.0					YES	4.1		YES
213	4.33	A	22	40.0					YES	4.0		YES
214	4.36	A	22	40.0					YES	4.1		YES
215	4.35	A	22	40.0					YES	4.1		YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 16

TYPE OF TEST: DEVELOPMENT		PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT		PART NUMBER: 10362	
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.		LOT NO.	LOT SIZE	CRN: 4264	PROCEDURE NUMBER & PARA. NO.
TEST START: 5-13-74	TEST COMPLETE: 5-13-74	AMB. TEMP.: 71°F	REL. HUMIDITY: 50%	TEST EQUIPMENT NUMBERS	

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)	NO-FIRE (AMP)	TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
216	4.64	B			0.140				YES			YES
217	4.74	B			0.135				YES			YES
218	4.28	B			0.130				YES			YES
219	3.93	B			0.125				YES			YES
220	4.08	B			0.120				YES			YES
221	4.34	B			0.115				NO			NO
222	4.22	B			0.120				NO			NO
223	4.33	B			0.125				YES			YES
224	4.64	B			0.120				NO			NO
225	4.67	B			0.125				YES			YES
226	4.65	B			0.120				NO			NO
227	4.67	B			0.125				NO			NO
228	4.63	B			0.130				YES			YES
229	4.60	B			0.125				YES			YES
230	4.68	B			0.120				NO			NO

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 17

TYPE OF TEST: DEVELOPMENT	PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT	PART NUMBER: 10362
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.	LOT NO. / LOT SIZE / CRN: 4264	PROCEDURE NUMBER & PARA. NO.
TEST START: 5-13-74 / TEST COMPLETE: 5-13-74	AMB. TEMP. / REL. HUMIDITY	TEST EQUIPMENT NUMBERS

SPECIMEN		TEST					BOOSTER CLOSURE		TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST(1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)	NO-FIRE (AMP)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
231	4.72	B			0.125				YES			YES
232	4.74	B			0.120				No			No
233	4.76	B			0.125				YES			YES
234	4.69	B			0.120				YES			YES
235	4.75	B			0.115				No			No
236	4.48	B			0.120				No			No
237	4.45	B			0.125				No			No
238	4.60	B			0.130				YES			YES
239	4.34	B			0.125				No			No
240	4.26	B			0.130				YES			YES
241	4.51	B			0.125				No			No
242	4.26	B			0.130				YES			YES
243	4.24	B			0.125				YES			YES
244	4.27	B			0.120				No			No
245	4.48	B			0.125				No			No

NOTES: (1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-2)
F - "Steel Barrier" Test (Figure B-4)
(2) Header assembly subjected to "no-fire" test

TABLE C-3

TEST DATA RECORDS

Sheet 18

DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10362	
MINIATURE PRECISION DETONATOR / HDR. ASSY.		4264	
5-13-74	5-13-74	71°F	50%

SPECIMEN		TEST							TEST RESULTS			
NO.	B/W(2) (OHM)	TEST(1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)	NO-FIRE (AMP)	TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (MSEC)	DENT (IN)	OPEN B/W (YES/NO)
221	4.43	A	22	30.0	SEE NOTE 2				NO			YES
222	4.20	A	22	30.0	SEE NOTE 2				NO			YES
224	4.62	A	22	30.0	SEE NOTE 2				NO			YES
226	4.57	A	22	30.0	SEE NOTE 2				NO			YES
227	4.71	A	22	30.0	SEE NOTE 2				NO			YES
230	4.62	A	22	30.0	SEE NOT 2				NO			YE
232	4.76	A	22	30.0	SEE NOTE 2				YES	6.9		YES
235	4.74	A	22	30.0	SEE NOTE 2				NO			YES
236	4.48	A	22	30.0	SEE NOTE 2				NO			YES
237	4.42	A	22	30.0	SEE NOTE 2				NO			YES
239	4.23	A	22	30.0	SEE NOTE 2				NO			YES
241	4.10	A	22	30.0	SEE NOTE 2				NO			YES
244	4.20	A	22	30.0	SEE NOTE 2				NO			YES
245	4.26	A	22	30.0	SEE NOTE 2				NO			YES

NOTES:

(1) Test Configurations --
- A - Header Assembly F[illegible]ction Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 19

TYPE OF TEST: DEVELOPMENT	PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT			PART NUMBER: 10314-103
PART NAME: MINIATURE PRECISION DETONATOR	LOT NO.:	LOT SIZE:	CRN: 4264	PROCEDURE NUMBER & PARA. NO.: ENVIRONMENT - T&H
TEST START: 4-22-74	TEST COMPLETE: 5-28-74	AMB. TEMP.: 70°F	REL. HUMIDITY: 52%	TEST EQUIPMENT NUMBERS:

SPECIMEN NO.	SPECIMEN B/W (OHM)	TEST: TEST CONFIG.(1)	TEST: CAP. (UFD)	TEST: CAP. VOLT. (VOLT)	TEST: B/W (OHM) (2)	TEST: TEST GAP (IN)	BOOSTER CLOSURE: TYPE	BOOSTER CLOSURE: THICK. (IN)	TEST RESULTS DETONATOR: FUNC. (YES/NO)	TEST RESULTS DETONATOR: FUNC. TIME (MSEC)	TEST RESULTS DETONATOR: DENT (IN)	BOOST. FUNC. (YES/NO)
301	3.18				3.14				SEE NOTE 3			
302	3.02								SEE NOTE 3			
303	3.04	C	22	40.0	2.92	0.250			YES	1.4	0.035	
304	4.62	C	22	40.0	4.47	0.250			NO			
305	3.26	C	22	40.0	3.11	0.250			YES	1.4	0.040	
306	2.84	C	22	40.0	2.86	0.250			NO			
307	3.18	C	22	40.0	3.09	0.250			NO			
308	3.20	C	22	40.0	3.15	0.250			YES	1.5	0.033	
309	3.05								SEE NOTE 3			
310	4.66								SEE NOTE 3			
311	3.23	C	22	40.0	3.12	0.250			NO			
312	3.14				3.03				SEE NOTE 3			
313	3.81		22	40.0	4.62				NO			
314	2.96	C	22	40.0	2.87	0.250			NO			
315	3.48	C	22	40.0	3.32	0.250			YES	1.4	0.034	

NOTES: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "no-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

(2) Header assembly subjected to "no-fire" test

TABLE C-3

TEST DATA RECORDS

Sheet 20

DEVELOPMENT			SENSITIVITY/ FUNCTION TIME/OUTPUT		10314-103
MINIATURE PRECISION DETONATOR				4264	ENVIRONMENT - T&H
4-22-74	5-28-74		70°F	52%	

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)	B/W (OHM) (2)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
316	3.06	C	22	40.0	2.95	0.250			YES	1.5	0.043	
317	2.92	C	22	40.0	2.80	0.250			YES	1.6	0.032	
318	3.50				3.33				SEE NOTE 4			
319	3.26	C	22	40.0	3.16	0.250			YES	1.4	0.040	
320	2.77	C	22	40.0	2.73	0.250			YES	1.5	0.041	
321	2.71	F	22	40.0	2.60	0.100			YES	1.3	SEE NOTE (3)	
322	2.98	F	22	40.0	2.89	0.100			YES	1.4	SEE NOTE (3)	
323	3.18	F	22	40.0	3.06	0.100			YES	1.3	SEE NOTE (3)	
324	3.12				2.90				SEE NOTE 4			
325	3.40		22	40.0	3.28				NO			
326	4.14				3.84				SEE NOTE 4			
327	3.74	C	22	40.0	3.63	0.250			NO			
328	3.45	F	22	40.0	3.61	0.100			YES	1.6	SEE NOTE (3)	
329	3.09				4.40				SEE NOTE 4			
330	3.89	C	22	40.0	4.01	0.250			NO			

Notes: (1) Test Configurations --

- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After T&H Test

(3) Barrier penetration: 1st - hole; 2d - partial; 3d - dent; 4th - none

(4) Broken lead

TABLE C-3

TEST DATA RECORDS

Sheet 21

TYPE OF TEST		PARAMETER				ACT NUMBER		
DEVELOPMENT		SENSITIVITY/ FUNCTION TIME/OUTPUT				10314-103		
PART NAME MINIATURE PRECISION DETONATOR		LOT NO.			RS 4264	PROCEDURE NUMBER & PARA. ENVIRONMENT - T&H		
TEST START 4-22-74	TEST COMPLETE 5-28-74	AMB. TEMP. 70°F		REL. HUMIDITY 52%		TEST EQUIPMENT NUMBERS		

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST (1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)	(2) B/W (OHM)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
331	3.10	F	22	40.0	3.12				No			
332	4.05	F	22	40.0	4.11	0.100			YES	1.4	SEE NOTE (3)	

NOTES: (1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)
(2) Bridgewire Resistance After T&H Test
(3) Barrier penetration: 1st - hole; 2d - partial; 3d - dent 4th - none

TABLE C-3

TEST DATA RECORDS

Sheet 22

TYPE OF TEST: DEVELOPMENT	PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT	PART NUMBER: 10314-103
PART NAME: MINIATURE PRECISION DETONATOR	LOT NO.: / LOT SIZE: / S/N: 4264	PROCEDURE NUMBER & PARA. NO.: ENVIRONMENT - SHOCK
TEST START: 4-22-74 / TEST COMPLETE: 5-28-74	AMB. TEMP.: 70 °F / REL. HUMIDITY: 52 %	TEST EQUIPMENT NUMBERS:

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)	(2) B/W (OHM)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
333	3.12	C	22	40.0	3.20	0.250			No			
334	2.88	C	22	40.0	2.91	0.250			YES	1.3	0.037	
335	2.90	C	22	40.0	2.96	0.250			No			
336	3.99	C	22	40.0	4.08	0.250			No			
337	3.59	C	22	40.0	3.69	0.250			YES	1.3	0.042	
338	4.20	C	22	40.0	4.64	0.250			No			
339	3.26	C	22	40.0	3.33	0.250			No			
340	3.06	C	22	40.0	3.12	0.250			No			
341	3.11	C	22	40.0	3.24	0.250			No			
342	3.19	C	22	40.0	3.30	0.250			No			
343	3.26	C	22	40.0	3.32	0.250			No			
344	3.64	C	22	40.0	3.75	0.250			YES	1.6	0.034	
345	2.90	C	22	40.0	2.96	0.250			No			
346	3.27	C	22	40.0	3.40	0.250			No			
347	2.84	C	22	40.0	2.90	0.250			YES	1.4	0.036	

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Bridgewire Resistance After 15,000-g shock

(3) Broken Lead

TABLE C-3

TEST DATA RECORDS

Sheet 23

DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10314-103
PART NAME MINIATURE PRECISION DETONATOR	4264	
TEST START 5-15-74	TEST COMPLETE 5-28-74	70°F / 50%

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST(1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST CAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
348	2.79	C	22	40.0		0.250			YES	1.5	0.030	
349	3.16	C	22	40.0		0.250			YES	1.4	0.034	
350	3.50	C	22	40.0		0.250			NO			
351	2.72	C	22	40.0		0.250			YES	1.4	0.032	
352	4.17	C	22	40.0		0.250			YES	1.3	0.033	
353	4.29	C	22	40.0		0.250			YES	1.3	0.031	
354	4.28	C	22	40.0		0.250			YES	1.5	0.046	
355	3.22	C	22	40.0		0.250			YES	1.5	0.041	
356	4.43	C	22	40.0		0.250			NO			
357	4.34	C	22	40.0		0.250			YES	1.4	0.034	
358	3.09	C	22	40.0		0.250			YES	1.5	0.035	
359	3.44	C	22	40.0		0.250			YES	1.4	0.032	
360	2.98	C	22	40.0		0.250			YES	1.3	0.037	
361	3.42	C	22	40.0		0.250			NO			
362	3.22	C	22	40.0		0.250			YES	1.3	0.030	

NOTES: (1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 24

TYPE OF TEST: DEVELOPMENT				PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT					AGE NUMBER: 10314-103			
PART NAME: MINIATURE PRECISION DETONATOR							LOT: 4264		PROCEDURE NUMBER & PARA. NO.			
TEST START: 5-15-74		TEST END: 5-28-74		AMB. TEMP.: 70°F			REL. HUM.: 50%					

SPECIMEN NO.	SPECIMEN B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	DETONATOR FUNC. (YES/NO)	DETONATOR FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
363	2.77	E	22	40.0		0.075	AL	0.020	YES	1.2		YES
364	3.00	E	22	40.0		0.075	AL	0.025	YES	1.2		NO
365	3.32	E	22	40.0		0.075	AL	0.025	YES	1.2		NO
366	3.80	E	22	40.0		0.075	AL	0.020	YES	1.3		YES
367	3.86	E	22	40.0		0.075	AL	0.020	YES	1.3		NO
368	3.65	E	22	40.0		0.075	AL	0.020	YES	1.2		YES
369	3.65	E	22	40.0		0.075	AL	0.020	YES	1.2		NO
370	3.25	E	22	40.0		0.075	AL	0.020	YES	1.3		NO
371	3.36	E	22	40.0		0.075	AL	0.020	YES	1.3		YES
372	3.52	E	22	40.0		0.075	AL	0.016	YES	1.3		YES
373	3.09	E	22	40.0		0.075	AL	0.016	YES	1.3		NO
374	3.68	E	22	40.0		0.075	AL	0.016	YES	1.4		YES
375	3.64	E	22	40.0		0.075	AL	0.016	YES	1.5		NO
376	2.84	E	22	40.0		0.075	AL	0.016	YES	1.4		NO
377	2.83	E	22	40.0		0.075	AL	0.016	YES	1.3		YES

Notes: (1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 25

DEVELOPMENT	PARAMETER SENSITIVITY/ FUNCTION TIME/OUTPUT	10314-103
PART NAME MINIATURE PRECISION DETONATOR	4264	
TEST START 5-15-74	5-28-74	70°F	50%

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST(1) CONFIG.	CAP. (μFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME ([illegible])	DENT (IN)	BOOST. FUNC. (YES/NO)
378	3.88	E	22	40.0		0.075	SS	0.005	YES	1.2		YES
379	4.00	E	22	40.0		0.075	SS	0.010	YES	1.2		YES
380	3.31	E	22	40.0		0.075	SS	0.015	YES	1.3		YES
381	2.77	E	22	40.0		0.075	SS	0.022	YES	1.3		NO
382	3.38	E	22	40.0		0.075	SS	0.015	YES	1.2		YES
383	4.36	E	22	40.0		0.075	SS	0.015	YES	1.2		YES
384	3.73	E	22	40.0		0.075	SS	0.015	YES	1.1		NO
385	2.98	E	22	40.0		0.075	SS	0.015	YES	1.3		NO
386	4.12	E	22	40.0		0.075	SS	0.015	YES	1.2		NO
387	4.47	E	22	40.0		0.075	SS	0.015	YES	1.2		NO
388	4.31	E	22	40.0		0.075	SS	0.015	YES	1.1		YES
389	3.57	E	22	40.0		0.075	SS	0.010	YES	1.4		YES
390	3.45	E	22	40.0		0.075	SS	0.010	YES	1.3		YES
391	3.21	E	22	40.0		0.075	SS	0.010	YES	1.3		YES
392	3.19	E	22	40.0		0.075	SS	0.010	YES	1.3		YES

NOTES: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 26

DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10314-103
PART NAME MINIATURE PRECISION DETONATOR	LOT NO. | 4264	PROCEDURE NUMBER & DATA
TEST START 5-15-74 | TEST COMPLETE 5-28-74	AMB. TEMP. 70°F | REL. HUMIDITY 50%	TEST EQUIPMENT NUMBERS

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OHM)	TEST(1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	BOOST. FUNC. (YES/NO)
393	4.24	F	22	40.0		0.100			YES	1.3		
394	3.49	F	22	40.0		0.100			No			
395	3.04	F	22	40.0		0.100			No			
396	3.49	F	22	40.0		0.100			YES	1.5		
397	3.04	F	22	40.0		0.100			YES	1.5		
398	3.35	F	22	40.0		0.100			No			
399	3.99	F	22	40.0		0.100			YES	1.4		
400	3.57	F	22	40.0		0.100			No			
401	2.82	F	22	40.0		0.100			YES	1.4		
402	3.89	F	22	40.0		0.100			No			

NOTES: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 27

TYPE OF TEST		PARAMETER		PART NUMBER
DEVELOPMENT		SENSITIVITY/ FUNCTION TIME/OUTPUT		10507
PART NAME MINIATURE PRECISION DETONATOR / HDR. ASSY.		LOT NO.	LOT SIZE / CRN 4264	PROCEDURE NUMBER & PARA. NO.
TEST START 5-3-74	TEST COMPLETE 5-28-74	AMB. TEMP. 70°F	REL. HUMIDITY 50%	TEST EQUIPMENT NUMBERS

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
411	3.89	A	1	5.0					No	–		No
412	4.15	A	1	5.0					No	–		No
413	3.93	A	1	5.0					No	–		No
414	4.04	A	1	5.0					No	–		No
415	4.24	A	1	5.0					No	–		No
416	3.67	A	1	10.0					No	–		YES
417	4.27	A	1	10.0					No	–		YES
418	4.60	A	1	10.0					No	–		YES
419	4.34	A	1	10.0					No	–		YES
420	4.31	A	1	10.0					No	–		YES
421	3.91	A	1	20.0					No	–		YES
422	3.97	A	1	20.0					No	–		YES
423	3.56	A	1	20.0					No	–		YES
424	3.66	A	1	20.0					No	–		YES
425	3.65	A	1	20.0					No	–		YES

NOTES:

(1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 28

TYPE OF TEST	PARAMETER	PART NUMBER
DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10507
PART NAME MINIATURE PRECISION DETONATOR / HDR. ASSY.	LOT NO. / LOT SIZE / CRN 4264	PROCEDURE NUMBER & PARA. NO.
TEST START 5-3-74 / TEST COMPLETE 5-28-74	AMB. TEMP. 70°F / REL. HUMIDITY 50%	TEST EQUIPMENT NUMBERS

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (MSEC)	DENT (IN)	OPEN B/W (YES/NO)
426	4.63	A	1	20.0					No	–		YES
427	3.54	A	1	20.0					No	–		YES
428	4.12	A	1	20.0					No	–		YES
429	3.96	A	1	20.0					No	–		YES
430	3.68	A	1	20.0					No	–		YES
431	4.36	A	1	30.0					YES	0.7		YES
432	3.79	A	1	30.0					No	–		YES
433	4.44	A	1	30.0					YES	0.5		YES
434	4.59	A	1	30.0					No	–		YES
435	3.30	A	1	30.0					YES	0.6		YES
436	3.29	A	1	30.0					YES	0.7		YES
437	3.44	A	1	30.0					YES	0.9		YES
438	3.58	A	1	30.0					No	–		YES
439	3.62	A	1	30.0					No	–		YES
440	3.61	A	1	30.0					No	–		YES

Notes: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 29

TYPE OF TEST: DEVELOPMENT			PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT				PART NUMBER: 10507			
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.			LOT NO.	LOT SIZE	CRN: 4264		PROCEDURE NUMBER & PARA. NO.			
TEST START: 5-3-74	TEST COMPLETE: 5-28-74		AMB. TEMP.: 70°F	REL. HUMIDITY: 50 %			TEST EQUIPMENT NUMBERS			

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
							BOOSTER CLOSURE					
NO.	B/W (OHM)	TEST[(1)] CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
441	4.09	A	1	30.0					NO	–		YES
442	4.13	A	1	30.0					YES	0.6		YES
443	3.74	A	1	30.0					YES	0.7		YES
444	3.44	A	1	30.0					YES	0.6		YES
445	4.32	A	1	30.0					NO	–		YES
446	3.69	A	1	30.0					NO	–		YES
447	3.73	A	1	30.0					NO	–		YES
448	3.68	A	1	30.0					YES	0.7		YES
449	4.19	A	1	30.0					NO	–		YES
450	3.73	A	1	30.0					YES	0.6		YES
451	3.62	A	1	40.0					YES	0.9		YES
452	3.96	A	1	40.0					NO	–		YES
453	3.63	A	1	40.0					NO	–		YES
454	3.40	A	1	40.0					YES	0.5		YES
455	3.15	A	1	40.0					YES	0.5		YES

NOTES: (1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 30

TYPE OF TEST: DEVELOPMENT		PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT			PART NUMBER: 10507
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.		LOT NO.	LOT SIZE	CRN: 4264	PROCEDURE NUMBER & PARA. NO.
TEST START: 5-3-74	TEST COMPLETE: 5-28-74	AMB. TEMP.: 70°F	REL. HUMIDITY: 50%		TEST EQUIPMENT NUMBERS

SPECIMEN NO.	SPECIMEN B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
456	4.75	A	1	40.0					YES	0.5		YES
457	4.69	A	1	40.0					YES	0.5		YES
458	4.88	A	1	40.0					YES	0.4		YES
459	4.64	A	1	40.0					YES	0.4		YES
460	4.23	A	1	40.0					YES	0.4		YES
461	3.64	A	1	40.0					YES	0.5		YES
462	3.67	A	1	40.0					YES	0.4		YES
463	3.61	A	1	40.0					NO	—		YES
464	3.54	A	1	40.0					YES	0.5		YES
465	3.27	A	1	40.0					YES	0.4		YES
466	3.15	A	1	40.0					YES	0.4		YES
467	4.33	A	1	40.0					YES	0.5		YES
468	4.34	A	1	40.0					YES	0.5		YES
469	3.93	A	1	40.0					YES	0.4		YES
470	4.72	A	1	40.0					YES	0.5		YES

NOTES: (1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 31

TYPE OF TEST: DEVELOPMENT		PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT		PART NUMBER: 10507
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.		LOT NO.	LOT SIZE	DN: 4264	PROCEDURE NUMBER & PARA. NO.
TEST START: 5-3-74	TEST COMPLETE: 5-28-74	AMB. TEMP.: 70°F	REL. HUMIDITY: 50%	TEST EQUIPMENT NUMBERS

SPECIMEN NO.	SPECIMEN B/W (OHM)	TEST (1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
471	4.13	A	4.7	5.0					No	–		YES
472	3.88	A	4.7	5.0					No	–		YES
473	3.98	A	4.7	5.0					No	–		YES
474	4.58	A	4.7	5.0					No	–		YES
475	3.92	A	4.7	5.0					No	–		YES
476	3.65	A	4.7	10.0					No	–		YES
477	2.97	A	4.7	10.0					No	–		YES
478	2.96	A	4.7	10.0					No	–		YES
479	4.01	A	4.7	10.0					No	–		YES
480	3.38	A	4.7	10.0					No	–		YES
481	3.50	A	4.7	20.0					No	–		YES
482	3.38	A	4.7	20.0					YES	0.8		YES
483	3.33	A	4.7	20.0					No	–		YES
484	3.13	A	4.7	20.0					YES	0.9		YES
485	3.22	A	4.7	20.0					No	–		YES

NOTES: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 32

TYPE OF TEST	PARAMETER	PART NUMBER
DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10507

PART NAME	LOT NO.	LOT SIZE	CRN	PROCEDURE NUMBER & PARA. NO.
MINIATURE PRECISION DETONATOR / HDR. ASSY.			4264	

TEST START	TEST COMPLETE	AMB. TEMP.	REL. HUMIDITY	TEST EQUIPMENT NUMBERS
5-3-74	5-28-74	70°F	50%	

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (MSEC)	DENT (IN)	OPEN B/W (YES/NO)
486	3.43	A	4.7	20.0					No	–		YES
487	3.16	A	4.7	20.0					YES	1.0		YES
488	4.88	A	4.7	20.0					No	–		YES
489	4.89	A	4.7	20.0					No	–		YES
490	4.47	A	4.7	20.0					No	–		YES
491	4.48	A	4.7	30.0					YES	0.5		YES
492	4.54	A	4.7	30.0					No	–		YES
493	4.44	A	4.7	30.0					No	–		YES
494	4.34	A	4.7	30.0					YES	0.6		YES
495	4.81	A	4.7	30.0					No	–		YES
496	3.31	A	4.7	30.0					YES	0.6		YES
497	3.90	A	4.7	30.0					YES	0.5		YES
498	4.92	A	4.7	30.0					No	–		YES
499	4.04	A	4.7	30.0					YES	0.7		YES
500	3.31	A	4.7	30.0					YES	0.5		YES

NOTES:

(1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 33

TYPE OF TEST: DEVELOPMENT				PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT					PART NUMBER: 10507			
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.				LOT NO.	LOT SIZE	CRN: 4264			PROCEDURE NUMBER & PARA. NO.			
TEST START: 5-3-74		TEST COMPLETE: 5-28-74		AMB. TEMP.: 70°F	REL. HUMIDITY: 50%				TEST EQUIPMENT NUMBERS			
SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
501	4.14	A	4.7	30.0					YES	0.6		YES
502	3.97	A	4.7	30.0					YES	0.7		YES
503	4.65	A	4.7	30.0					YES	0.6		YES
504	3.55	A	4.7	30.0					YES	0.6		YES
505	3.68	A	4.7	30.0					YES	0.5		YES
506	3.79	A	4.7	30.0					YES	0.6		YES
507	4.12	A	4.7	30.0					NO	—		YES
508	4.26	A	4.7	30.0					NO	—		YES
509	4.78	A	4.7	30.0					YES	0.7		YES
510	3.76	A	4.7	30.0					YES	0.5		YES
511	4.56	A	4.7	40.0					YES	0.65		YES
512	4.32	A	4.7	40.0					YES	0.5		YES
513	3.51	A	4.7	40.0					YES	0.6		YES
514	3.91	A	4.7	40.0					NO	—		YES
515	3.66	A	4.7	40.0					YES	0.5		YES

Notes: (1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 34

TYPE OF TEST: DEVELOPMENT	PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT	PART NUMBER: 10507
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.	LOT NO.: — LOT SIZE: — RN: 4264	PROCEDURE NUMBER & PARA. NO.:
TEST START: 5-3-74 / TEST COMPLETE: 5-28-74	AMB. TEMP.: 70°F / REL. HUMIDITY: 50%	TEST EQUIPMENT NUMBERS:

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
516	3.18	A	4.7	40.0					YES	0.45		YES
517	3.58	A	4.7	40.0					YES	0.5		YES
518	3.14	A	4.7	40.0					YES	0.5		YES
519	2.90	A	4.7	40.0					YES	0.5		YES
520	2.91	A	4.7	40.0					YES	0.5		YES
521	2.95	A	4.7	40.0					YES	0.6		YES
522	3.41	A	4.7	40.0					YES	0.55		YES
523	3.51	A	4.7	40.0					YES	0.6		YES
524	3.32	A	4.7	40.0					YES	0.6		YES
525	3.13	A	4.7	40.0					YES	0.5		YES
526	3.25	A	4.7	40.0					YES	0.55		YES
527	4.22	A	4.7	40.0					YES	0.5		YES
528	3.17	A	4.7	40.0					YES	0.55		YES
529	3.47	A	4.7	40.0					YES	0.5		YES
530	2.90	A	4.7	40.0					YES	0.45		YES

NOTES: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 35

TYPE OF TEST: DEVELOPMENT				PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT					PART NUMBER: 10507			
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.				LOT NO.	LOT SIZE	CRN: 4264			PROCEDURE NUMBER & PARA. NO.			
TEST START: 5-3-74		TEST COMPLETE: 5-28-74		AMB. TEMP.: 70°F		REL. HUMIDITY: 50%			TEST EQUIPMENT NUMBERS			
SPECIMEN		TEST							TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
531	3.64	A	22	5.0					No	–		YES
532	3.38	A	22	5.0					No	–		YES
533	3.58	A	22	5.0					No	–		YES
534	2.76	A	22	5.0					No	–		YES
535	3.09	A	22	5.0					No	–		YES
536	2.64	A	22	10.0					No	–		YES
537	2.82	A	22	10.0					No	–		YES
538	2.91	A	22	10.0					No	–		YES
539	2.79	A	22	10.0					No	–		YES
540	2.90	A	22	10.0					No	–		YES
541	4.49	A	22	20.0					No	–		YES
542	3.04	A	22	20.0					No	–		YES
543	3.09	A	22	20.0					No	–		YES
544	2.97	A	22	20.0					No	–		YES
545	3.17	A	22	20.0					No	–		YES

NOTES: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)

B - Header Assembly "No-fire" Test (Figure B-1)

C - Detonator Dent Output Test (Figure B-2)

D - Detonator Gap Test (Figure B-3)

E - Booster (Variable Closure) Initiation Test (Figure B-3)

F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 36

TYPE OF TEST: DEVELOPMENT				PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT				PART NUMBER: 10507			
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.				LOT NO.	LOT SIZE	LRN: 4264		PROCEDURE NUMBER & PARA. NO.			
TEST START: 5-3-74		TEST COMPLETED: 5-28-74		AMB. TEMP.: 70°F		REL. HUMIDITY: 50%		TEST EQUIPMENT NUMBERS			
SPECIMEN		TEST						TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST (1) CONFIG.	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
546	3.00	A	22	20.0					NO	—		YES
547	2.82	A	22	20.0					YES	0.7		YES
548	3.06	A	22	20.0					YES	0.8		YES
549	3.18	A	22	20.0					YES	1.0		YES
550	3.22	A	22	20.0					YES	0.9		YES
551	2.76	A	22	30.0					YES	0.6		YES
552	3.21	A	22	30.0					NO	—		YES
553	3.01	A	22	30.0					YES	0.6		YES
554	3.47	A	22	30.0					YES	0.6		YES
555	2.95	A	22	30.0					YES	0.5		YES
556	3.76	A	22	30.0					YES	0.6		YES
557	3.51	A	22	30.0					YES	0.5		YES
558	4.21	A	22	30.0					NO	—		YES
559	3.65	A	22	30.0					NO	—		YES
560	3.84	A	22	30.0					YES	0.6		YES

NOTES: (1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 37

TYPE OF TEST: DEVELOPMENT			PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT					PART NUMBER: 10507			
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.			LOT NO.		LOT SIZE	CRN 4264		PROCEDURE NUMBER & PARA. NO.			
TEST START: 5-3-74		TEST COMPLETE: 5-28-74		AMB. TEMP.: 70°F		REL. HUMIDITY: 50%		TEST EQUIPMENT NUMBERS			
SPECIMEN		TEST						TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (MSEC)	DENT (IN)	OPEN B/W (YES/NO)
561	4.83	A	22	30.0					No	–		YES
562	4.73	A	22	30.0					YES	0.6		YES
563	4.61	A	22	30.0					No	–		YES
564	4.65	A	22	30.0					No	–		YES
565	3.43	A	22	30.0					YES	0.6		YES
566	2.85	A	22	30.0					YES	0.6		YES
567	2.71	A	22	30.0					YES	0.5		YES
568	3.71	A	22	30.0					YES	0.6		YES
569	3.45	A	22	30.0					YES	0.7		YES
570	3.09	A	22	30.0					YES	0.6		YES
571	3.24	A	22	40.0					YES	0.5		YES
572	2.95	A	22	40.0					YES	0.4		YES
573	3.21	A	22	40.0					YES	0.5		YES
574	3.29	A	22	40.0					YES	0.5		YES
575	2.92	A	22	40.0					YES	0.5		YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test
- F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 38

TYPE OF TEST	PARAMETER	PART NUMBER
DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10507

PART NAME	LOT NO.	LOT SIZE	CRN	PROCEDURE NUMBER & PARA. NO.
MINIATURE PRECISION DETONATOR / HDR. ASSY.			4264	

TEST START	TEST COMPLETE	AMB. TEMP.	REL. HUMIDITY	TEST EQUIPMENT NUMBERS
5-3-74	5-28-74	70°F	50%	

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
							BOOSTER CLOSURE					
NO.	B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (MSEC)	DENT (IN)	OPEN B/W (YES/NO)
576	2.48	A	22	40.0					YES	0.4		YES
577	3.27	A	22	40.0					YES	0.5		YES
578	2.84	A	22	40.0					YES	0.6		YES
579	2.91	A	22	40.0					YES	0.5		YES
580	2.93	A	22	40.0					YES	0.6		YES
581	2.51	A	22	40.0					YES	0.5		YES
582	2.79	A	22	40.0					YES	0.5		YES
583	2.77	A	22	40.0					YES	0.4		YES
584	2.57	A	22	40.0					YES	0.5		YES
585	2.57	A	22	40.0					YES	0.5		YES
586	2.86	A	22	40.0					YES	0.5		YES
587	2.52	A	22	40.0					YES	0.3		YES
588	2.51	A	22	40.0					YES	0.4		YES
589	2.72	A	22	40.0					YES	0.4		YES
590	2.67	A	22	40.0					YES	0.4		YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test
- F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 39

TYPE OF TEST	PARAMETER		
DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT		10507
PART NAME MINIATURE PRECISION DETONATOR / HDR. ASSY.		4264	
TEST START 5-3-74	TEST COMPLETED 5-28-74	AMB. TEMP. 70°F	50%

SPECIMEN NO.	SPECIMEN B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)	NO-FIRE (AMP)	TEST GAP (IN)	BOOSTER CLOSURE TYPE	BOOSTER CLOSURE THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
591	3.26	A	22	40.0					YES	0.5		YES
592	3.51	A	22	40.0					YES	0.4		YES
593	3.52	A	22	40.0					YES	0.4		YES
594	3.10	A	22	40.0					YES	0.4		YES
595	2.88	A	22	40.0					YES	0.5		YES
596	2.93	A	22	40.0					YES	0.5		YES
597	3.04	A	22	40.0					YES	0.4		YES
598	3.20	A	22	40.0					YES	0.4		YES
599	2.93	A	22	40.0					YES	0.5		YES
600	3.29	A	147	30.0					YES	0.4		YES
601	2.74	A	147	30.0					YES	0.5		YES
602	4.56	A	147	30.0					NO	—		YES
603	3.09	A	147	30.0					YES	0.6		YES
604	4.42	A	147	30.0					YES	0.5		YES
605	2.82	A	147	30.0					YES	0.4		YES

NOTES: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 40

TYPE OF TEST			PARAMETER					PART NUMBER			
DEVELOPMENT			SENSITIVITY/ FUNCTION TIME/OUTPUT					10507			
PART NAME MINIATURE PRECISION DETONATOR / HDR. ASSY			LOT NO.	LOT SIZE	S/N 4264			PROCEDURE NUMBER & PARA. NO.			
TEST START 5-3-74	TEST COMPLETE 5-28-74		AMB. TEMP. 70°F	REL. HUMIDITY 50%				TEST EQUIPMENT NUMBERS			

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
							BOOSTER CLOSURE					
NO.	B/W (OHM)	TEST CONFIG.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
606	2.82	A	147	30.0					YES	0.4		YES
607	2.76	A	147	30.0					YES	0.4		YES
608	2.79	A	147	30.0					YES	0.4		YES
609	2.98	A	147	30.0					YES	0.5		YES
610	2.91	A	147	30.0					YES	0.5		YES
611	3.24	A	147	30.0					YES	0.5		YES
612	2.87	A	147	30.0					YES	0.5		YES
613	3.46	A	147	30.0					YES	0.4		YES
614	2.85	A	147	30.0					YES	0.4		YES
615	3.01	A	22	40.0					YES	0.4		YES
616	2.66	A	22	40.0					YES	0.4		YES
617	2.95	A	22	40.0					YES	0.5		YES
618	2.77	A	22	40.0					YES	0.5		YES
619	3.47	A	22	40.0					YES	0.4		YES
620	2.74	A	22	40.0					YES	0.4		YES

NOTES: (1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 41

TYPE OF TEST: DEVELOPMENT	PARAMETER: SENSITIVITY/ FUNCTION TIME/OUTPUT		PART NUMBER: 10507
PART NAME: MINIATURE PRECISION DETONATOR / HDR. ASSY.	LOT NO.	LOT SIZE / CRN: 4264	PROCEDURE NUMBER & PARA. NO.
TEST START: 5-3-74 / TEST COMPLETE: 5-28-74	AMB. TEMP.: 70°F	REL. HUMIDITY: 50%	TEST EQUIPMENT NUMBERS

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
							BOOSTER CLOSURE					
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
621	2.71	A	22	40.0					YES	0.4		YES
622	2.90	A	22	40.0					YES	0.5		YES

NOTES: (1) Test Configurations --

A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 42

TYPE OF TEST	PARAMETER	PART NUMBER
DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT	10507

PART NAME	LOT NO.	LOT SIZE	CRN	PROCEDURE NUMBER & PARA. NO.
MINIATURE PRECISION DETONATOR / HDR. ASSY.			4264	

TEST START	TEST COMPLETE	AMB. TEMP.	REL. HUMIDITY	TEST EQUIPMENT NUMBERS
5-13-74	5-28-74	71°F	50%	

SPECIMEN		TEST							TEST RESULTS SPECIMEN			
							BOOSTER CLOSURE					
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)	NO-FIRE (AMP)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
651	4.28	B			0.150				YES			YES
652	3.34	B			0.145				YES			YES
653	4.12	B			0.140				No			YES
654	4.52	B			0.145				YES			YES
655	3.02	B			0.140				No			YES
656	3.23	B			0.145				YES			YES
657	2.97	B			0.140				No			YES
658	2.89	B			0.145				No			YES
659	3.33	B			0.150				YES			YES
660	3.00	B			0.145				No			YES
661	3.44	B			0.150				YES			YES
662	3.35	B			0.145				YES			YES
663	3.13	B			0.140				YES			YES
664	3.20	B			0.135				YES			YES
665	3.54	B			0.130				YES			YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

TABLE C-3

TEST DATA RECORDS

Sheet 43

TYPE OF TEST			PARAMETER				PART NUMBER			
DEVELOPMENT			SENSITIVITY/ FUNCTION TIME/OUTPUT				10507			
PART NAME MINIATURE PRECISION DETONATOR / HDR. ASSY.			LOT NO.	LOT SIZE	S/N 4264		PROCEDURE NUMBER & PARA. NO.			
TEST START 5-13-74		TEST COMPLETE 5-28-74	AMB. TEMP. 71°F		REL. HUMIDITY 50 %		TEST EQUIPMENT NUMBERS			

SPECIMEN		TEST					BOOSTER CLOSURE		TEST RESULTS SPECIMEN			
NO.	B/W (OHM)	TEST CONFIC.(1)	CAP. (UFD)	CAP. VOLT. (VOLT)	NO-FIRE (AMP)	TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (YES/NO)	FUNC. TIME (USEC)	DENT (IN)	OPEN B/W (YES/NO)
666	3.98	B			0.125				No			YES
667	3.93	B			0.130				YES			YES
668	4.24	B			0.125				YES			YES
669	3.56	B			0.120				YES			YES
670	3.19	B			0.115				No			YES
671	3.20	B			0.120				No			YES
672	3.49	B			0.125				YES			YES
673	3.12	B			0.120				No			YES
674	3.21	B			0.125				No			YES
675	3.33	B			0.130				YES			YES
676	3.74	B			0.125				YES			YES
677	4.30	B			0.120				YES			YES
678	2.73	B			0.115				No			YES
679	4.10	B			0.120				YES			YES
680	4.37	B			0.115				YES			YES

NOTES:

(1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

TABLE C-3
TEST DATA RECORDS

Sheet 44

DEVELOPMENT	PARAMETER SENSITIVITY/ FUNCTION TIME/OUTPUT	PART NUMBER
PART NAME MINIATURE PRECISION DETONATOR	TEST NO. / UNIT SIZE / S/N 4264	PROCEDURE NUMBER & PARA. NO.
TEST START 6-12-74 / TEST COMPLETE 6-12-74	AMB. TEMP. 71 °F / REL. HUMIDITY 54 %	TEST EQUIPMENT

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			BOOSTER
NO.	B/W (OHM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (2) (YES/NO)	FUNC. TIME	DENT (IN)	FUNC.
1	NOTE 2,3	C				0.250			YES		0.020 0.025	
2		C				0.150			YES		0.013 0.016	
3		D				0.250	AL	.005	YES			YES
4		D				0.250	AL	.005	YES			YES
5		D				0.250	AL	.005	YES			YES
6		D				0.250	AL	.005	YES			YES
7		D				0.250	AL	.005	YES			YES
8		C				0.500			YES		0.020 0.030	
9		D				0.500	AL	.005	YES			YES
10		D				0.500	AL	.005	YES			NO
11		D				0.500	AL	.005	YES			YES
12		D				0.500	AL	.005	YES			NO
13		D				0.500	AL	.005	YES			YES
14	NOTE 2,3	D				0.500	AL	.005	YES			YES

NOTES: (1) Test Configurations --
A - Header Assembly Function Time Test (Figure B-1)
B - Header Assembly "No-fire" Test (Figure B-1)
C - Detonator Dent Output Test (Figure B-2)
D - Detonator Gap Test (Figure B-3)
E - Booster (Variable Closure) Initiation Test (Figure B-3)
F - "Steel Barrier" Test (Figure B-4)
(2) Det functioned with M100 match (no header)
(3) Can Base was flat

TABLE C-3

TEST DATA RECORDS

Sheet 45

DEVELOPMENT	SENSITIVITY/ FUNCTION TIME/OUTPUT		
MINIATURE PRECISION DETONATOR		4264	
6-11-74	6-12-74	72°F	52 %

SPECIMEN		TEST							TEST RESULTS			
							BOOSTER CLOSURE		DETONATOR			
NO.	B/W (OIM)	TEST CONFIG. (1)	CAP. (UFD)	CAP. VOLT. (VOLT)		TEST GAP (IN)	TYPE	THICK. (IN)	FUNC. (2) (YES/NO)	FUNC. TIME	DENT (IN)	BOOST. FUNC. (YES/NO)
1	NOTE 2,3	D				0.250	AL	.005	YES			NO
2		D				0.150	AL	.005	YES			NO
3		C				0.150			YES		0.030 0.041	
4		D				0.125	AL	.005	YES			YES
5		D				0.125	AL	.005	YES			YES
6		D				0.125	AL	.005	YES			YES
7		D				0.125	AL	.005	YES			NO
8		D				0.125	AL	.005	YES			YES
9		D				0.125	AL	.005	YES			YES
10		D				0.125	AL	.005	YES			YES
11		D				0.125	AL	.005	YES			YES
12		D				0.125	AL	.005	YES			YES
13	NOTE 2,3	D				0.125	AL	.005	YES			YES

NOTES: (1) Test Configurations --
- A - Header Assembly Function Time Test (Figure B-1)
- B - Header Assembly "No-fire" Test (Figure B-1)
- C - Detonator Dent Output Test (Figure B-2)
- D - Detonator Gap Test (Figure B-3)
- E - Booster (Variable Closure) Initiation Test (Figure B-3)
- F - "Steel Barrier" Test (Figure B-4)

(2) Det functioned with M100 match (no header)

(3) Can base was flat

APPENDIX D

RADC RELIABILITY EVALUATION OF MUNITION DEPOSITED

FUZE HEADER SAMPLES (P/N 08892)

Headquarters Armament Development and Test Center (AFSC), Eglin AFB, Florida, requested RADC reliability support involving evaluation of munition fuze headers on 27 February 1974. Attachment #1 is the formal correspondence from Headquarters ADTC/SDH requesting RADC support and containing device performance requirements, reliability problems of immediate concern and a tentative analysis plan. The analysis plan defined two categories, namely header material analysis and reliability stress tests. RADC/RBRP received nine (9) munition fuze headers for reliability assessment. RADC's evaluation of header materials and manufacturing processes indicated an inferior product from the reliability standpoint, thus the test program suggested was considered not warranted at this time. RADC analysis results documented herein respond to items 3b, c, d and e of referenced attachment #1. Mr. Origer ADTC/SDHZ stated by telecon on 14 March 74 that subject fuze headers were prototype samples for evaluation rather than actual devices currently incorporated in munition fuze designs. This report documents the fuze header analysis findings as conducted by the RADC QR Failure Analysis Activity. RADC/RBRP personnel assigned to this project were Messrs. J. J. Bart, C. J. Salvo and G. G. Sweet. RADC/RBRM personnel were Messrs. C. Lane and B. Moore.

Fuze Header Reliability Analysis Results:

Figures 1A and Lb show the fuze headers overall construction and EM photo of the header surface with deposited film geometry highlighted. Figure 1C SEM photos verify that the deposited two layer thin film was evaporated over the center conductor material. From this we also conclude that the film is smooth when compared with the plating on the inner and outer conductors. The film itself if designed as a fuzable link between two terminal conductors which is blown by energy from a capacitor discharge circuit. Lead Azide, $Pb(N_3)_2$, material is positioned over the fuze link and explodes when the film temperature reaches 350°C. Since lead azide is a needle-like crystal, it is assumed that these crystals are held in place with a binder (possibly dextrin-adhesive substance) when positioned over the film fuze link. The results of Electron Beam Microprobe X-Ray analysis identified the header materials and are listed below:

Thin film fuze material - vapor deposited two layer film of palladium (Pd) and silver (Ag). Optical and SEM analysis indicates that the Pd is deposited on the glass and conductor surfaces first followed by deposition of Ag.

Conductor materials - Both the center and outer rim portion of the header conductors are an iron-nickel-cobalt (Fe, Ni, Co) Kovar

material which has been plated with a gold (Au)-Tantalum (Ta) material. The color of this plating (silver-gray) indicates the simultaneous plating of both materials. The Au and Ta volume percentages were not determined.

Glass dielectric material - This insulator appears to be a low melting point glass containing: Sodium (Na), Potassium (K), Aluminum (Al), Silicon (Si) and Oxygen (O). Thus, the header construction implies a Kovar to glass seal, an established, reliable technology used throughout the microelectronics industry for package fabrication, however, the glass is not high purity.

The X-Ray spectral readouts for the above designated materials are shown in Figure 1D. Figure 2 shows the fuze link neckdown region and associated film profilometer trace where the measured total thickness was 6000 A°. The nominal resistance of the film as measured on all samples was 304 ohms. Figures 3 and 4 show two typical fuze headers with corresponding profilometer traces of the surface structure revealing step heights, general surface planarity variations and relative roughness of the materials. Figure 4B shows a SEM photomicrograph of an edge of the thin film fuze link pattern delineating the two layer deposition of Pd and Ag. Pd is deposited on the glass first because of its adherence properties, followed by Ag deposition. The Pd and Ag thicknesses could not be measured due to the geometrical properties of the profilometer stylus. It appears that two successive depositions, Pd then Ag, were made followed by film definition using photomasks and selective chemical etch of metals simultaneously. The exposed narrow width of Pd observed could be the result of inadequate etching time. Only one (1) of the nine (9) units exhibited this characteristic.

General Conclusions and Related Discussion:

(a) Materials Compatibility:

It appears that the selection of Ta-Au and Pd-Ag for conductor plating and fuze link respectively was based on the fact that these metals do not react with $Pb(N_3)_2$, lead azide, and as such represent a chemically inert material system. Although lead azide is not hygroscopic, it will react with water forming a compound (weak acid) which is also chemically inert with the fuze materials. Lead azide requires special handling for shipping and storage in that water submersion is necessary to reduce sensitivity. The use of the noble metals Au and Ag results in the absence of corrosion or oxidation problems. One potential reliability problem with the plating is porosity of the Ta-Au plate over Kovar. Kovar (Fe-Ni-Co) will rust in the presence of moisture and thus the porosity of the plating is

critical. Inspection of the fuze header plating indicates a poor quality plate with large pits and general surface roughness. If one also considers the intermetallics formed by the Ta-Au plate with the Pd-Ag film during deposition, it is a possibility that some degree of Kirkendall voiding will occur. The Kirkendall effect occurs in diffusion couples and involves mass transfer of one constituent due to a more rapid diffusion rate with resultant void formation on the side of the couple containing the faster-diffusing constituent. The severity of this voiding depends on temperature and time during deposition and the degree of voiding necessary to create a reliability problem (metal opens) depends on the film thickness and contact area and/or periphery. A more obvious condition which exists in these devices in the non-planarity of the glass between the center and outer cylindrical conductors. If a valley, due to glass dewetting, exists at the glass-center conductor interface, inadequate film coverage may occur during deposition leading to an open. In addition, the measured plating thickness to film thickness ratio (~ 6:1) is excessive again resulting in reduced coverage at the step and potential film opens.

(b) <u>Manufacturing Process Evaluation:</u>

Several characteristics of the fuze header structure are considered poor design from the reliability standpoint. The porosity of the Ta-Au plate can lead to rust in the presence of moisture. The excess step (~ 3.60μ) over which the ~ 0.60 μ Pd-Ag film is deposited could result in metal opens. The glass non-planarity may result in poor deposition and varying film thickness, especially at the narrow fuze link region, depending on the evaporation source configuration. It seems like polishing the glass to reasonable planarity prior to plating and thin film deposition would result in a more reliable product. Reducing the plate thickness and porosity would result in better step coverage of the thin film Pd-Ag over the plated conductors. The use of a high purity glass is commensurate with the 20 year storage requirement, yet a glass containing relatively high percentages of contaminants was used which exhibited voids (gas pockets) and general surface roughness. The thin film metal pattern positioning (centering) indicates a lack of process control in metal definition. Since maximum contact periphery minimizes the probability of metal film opens (thinning at steps), a critical requirement when coverage over large steps is involved as is the case here, a more reliable thin film design geometry would consist of complete overlap of the plated center conductor. This would result in maximum contact area and periphery at the center conductor to glass step. The manufacturers' current design obviously is not designed for contact reliability and improper film centering significantly reduces contact periphery.

(c) Environmental Screen Tests:

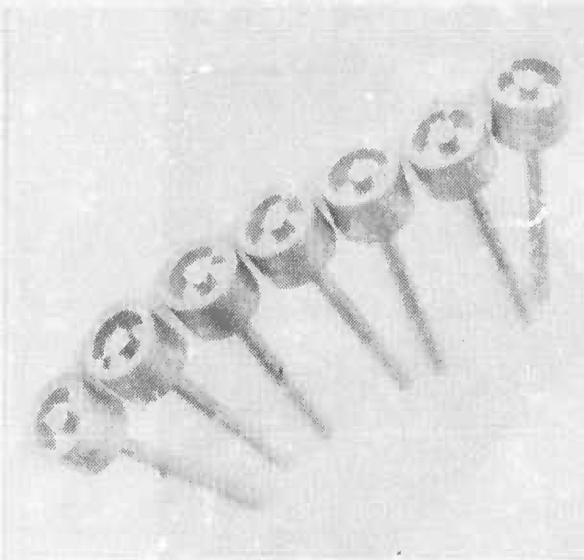
Based on the excessive center conductor step height to film thickness ratio (~ 6:1) we conclude that the most applicable environmental screen test to effectively remove potential fuze header metal open failures is thermal shock and/or temperature cycling with post electrical continuity tests.

RADC Recommended Fuze Header Disposition:

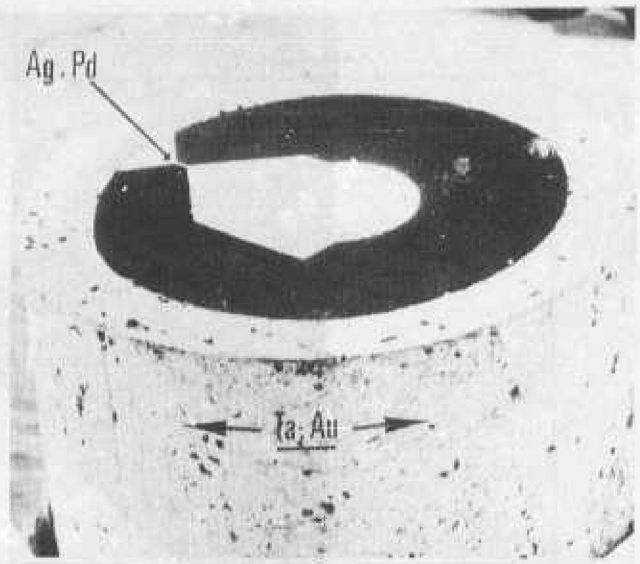
Based on the analysis findings, RADC considers these fuze headers not suitable for high-reliability applications. It was therefore decided that extensive environmental and thermal stress testing was not warranted at this time.

Edgar A. Doyle Jr.

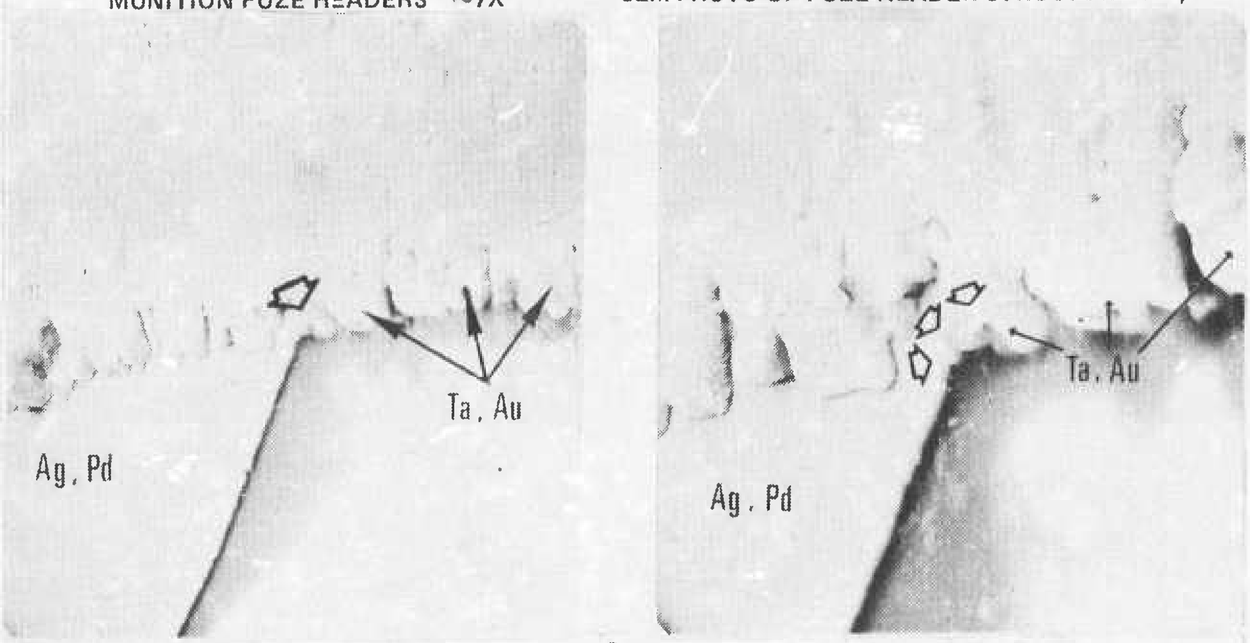
EDGAR A. DOYLE, JR.
Reliability Physics Section
Reliability Branch RADC



A
MUNITION FUZE HEADERS ~7X

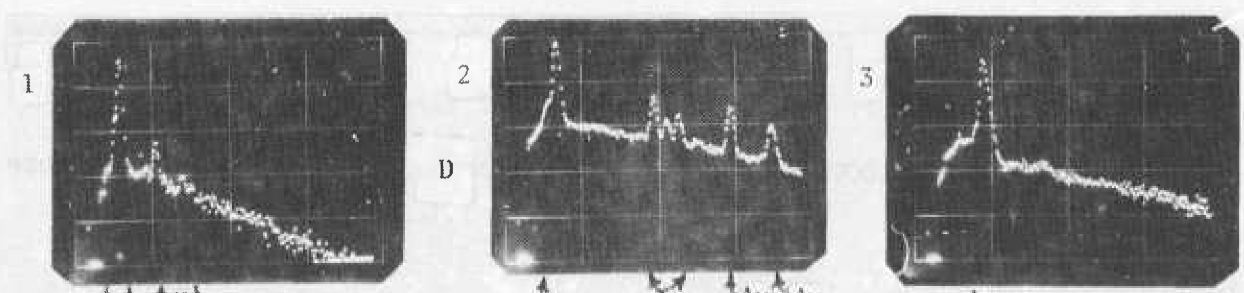


B
SEM PHOTO OF FUZE HEADER STRUCTURE 65°, 34X



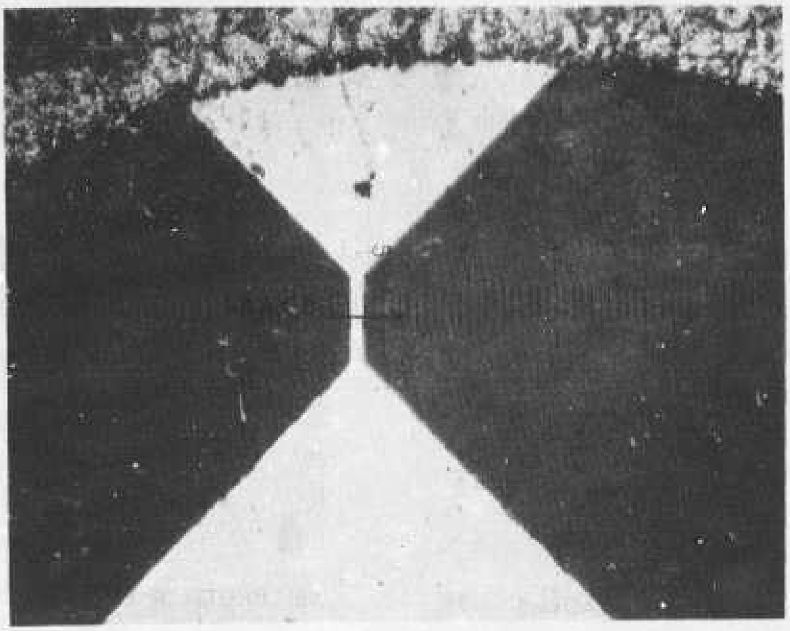
20KV, 50°, 520X C 20KV, 50°, 1700X

SEM Photos Verifying Pd, Ag Double Layer Thin Film
Deposited Over Ta-Au Plated Kovar



Electron Beam Microprobe Readouts (X-Ray Spectrum) of (1) Glass Composition,
(2) Center Conductor Plate and Base Material and (3) Thin Film Composition
Figure 1.

A



200X Scale = 6.25 μm/Div

B

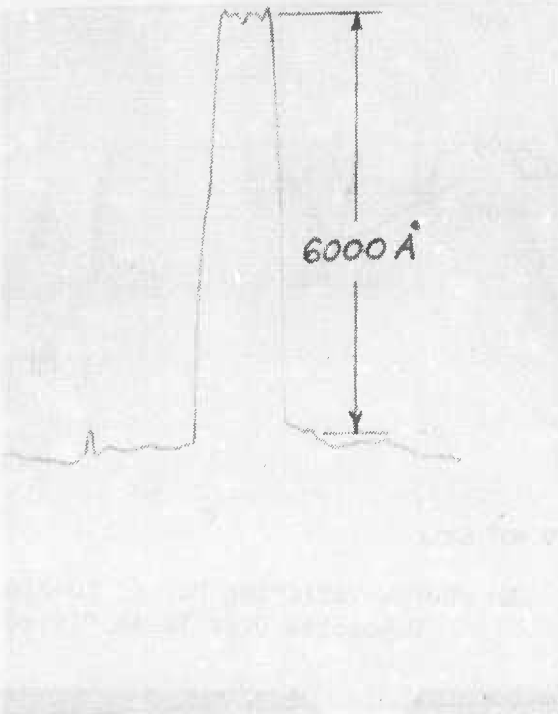
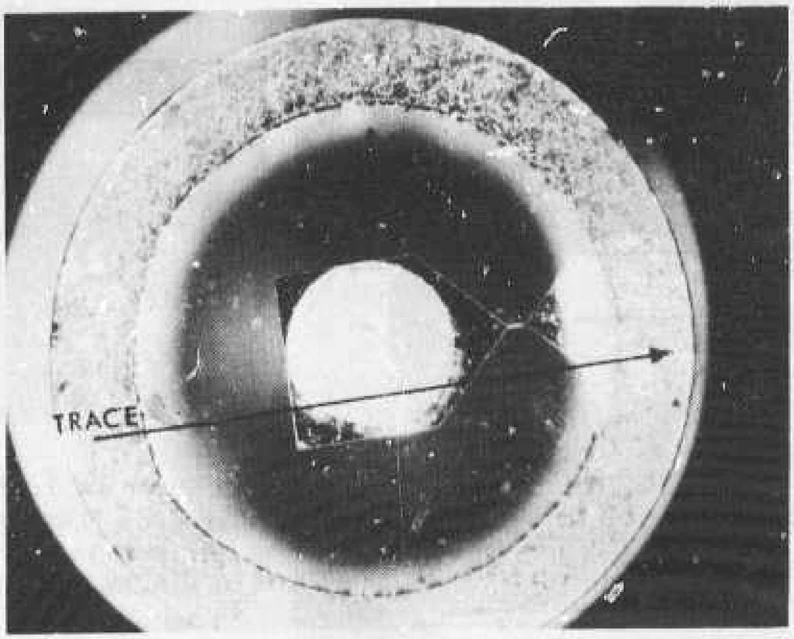


Figure 2. Photomicrograph and Profilometer Trace Showing Film Thickness of Fuze Link
Profilometer - 1000X Horizontal, 10K Angstroms Full Scale Vertical. Fuze #1

A



50X Darkfield

B

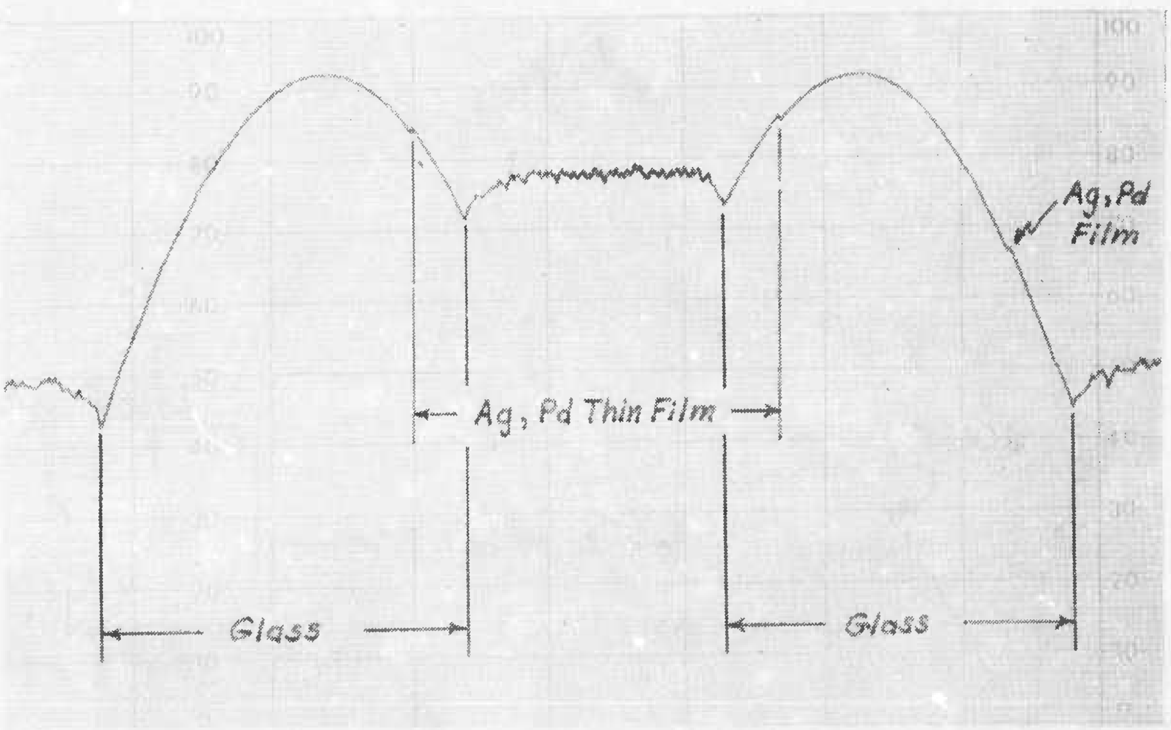
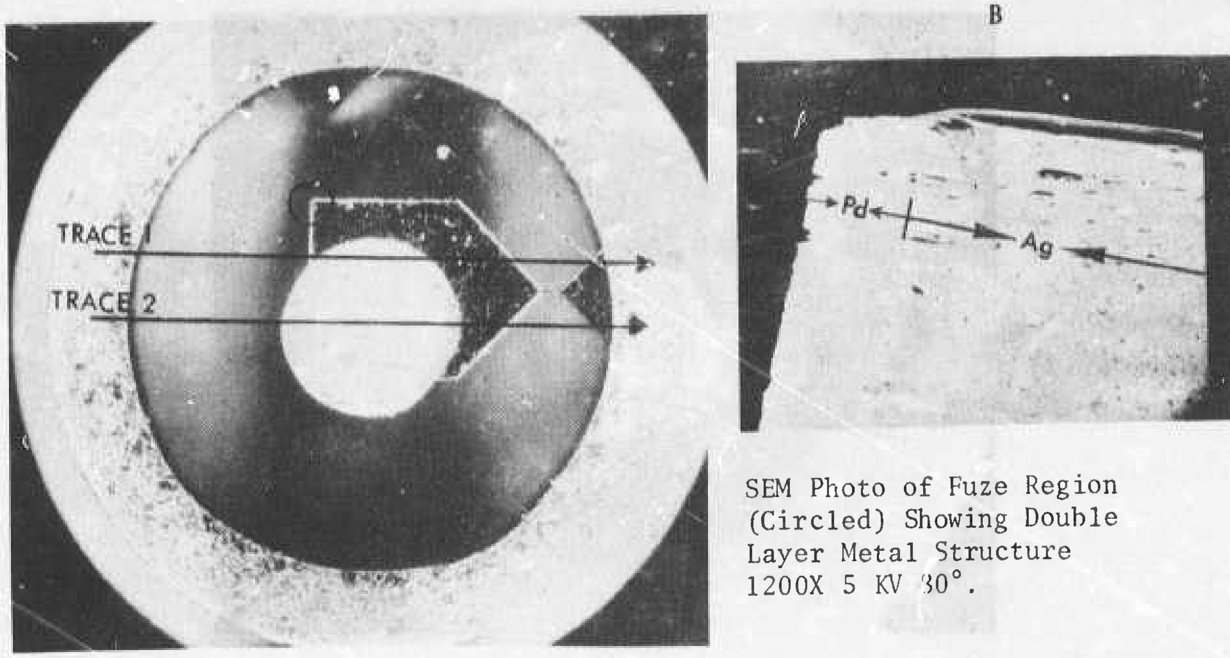


Figure 3. Photomicrograph and Profilometer Trace of Fuze Header
Profilometer - 100X Horizontal, 500K Angstroms Full Scale Vertical. Fuze #2

A

B



SEM Photo of Fuze Region (Circled) Showing Double Layer Metal Structure 1200X 5 KV 30°.

50X Darkfield

C

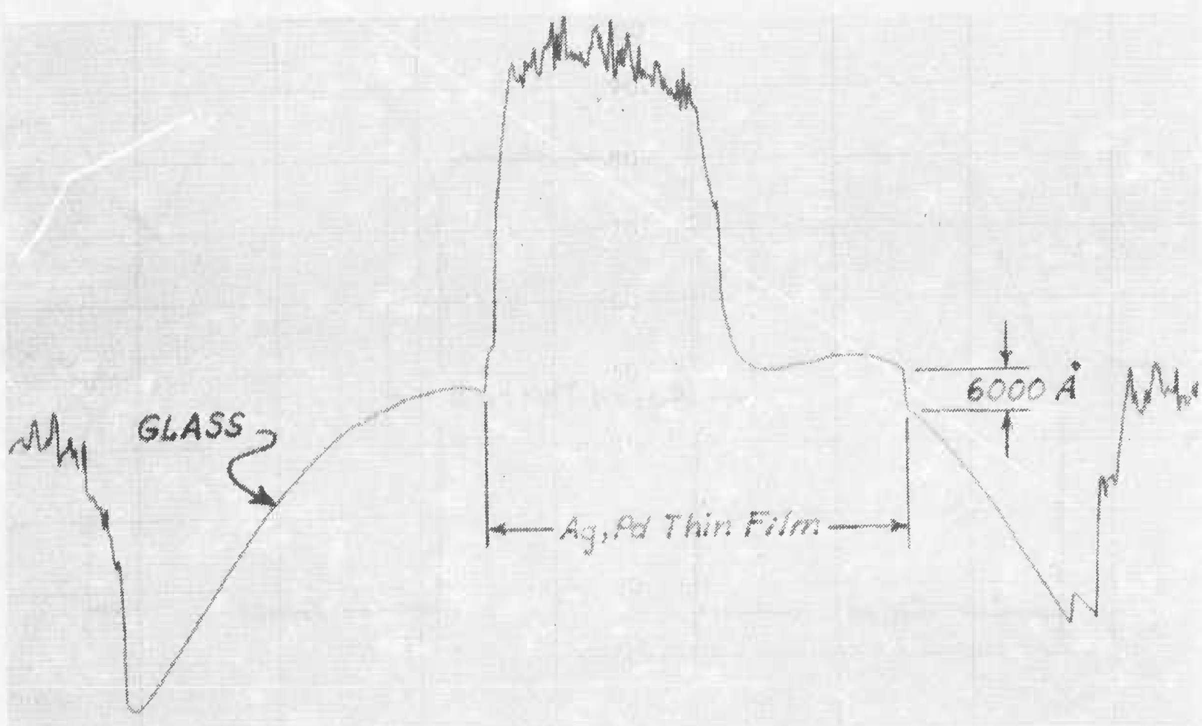
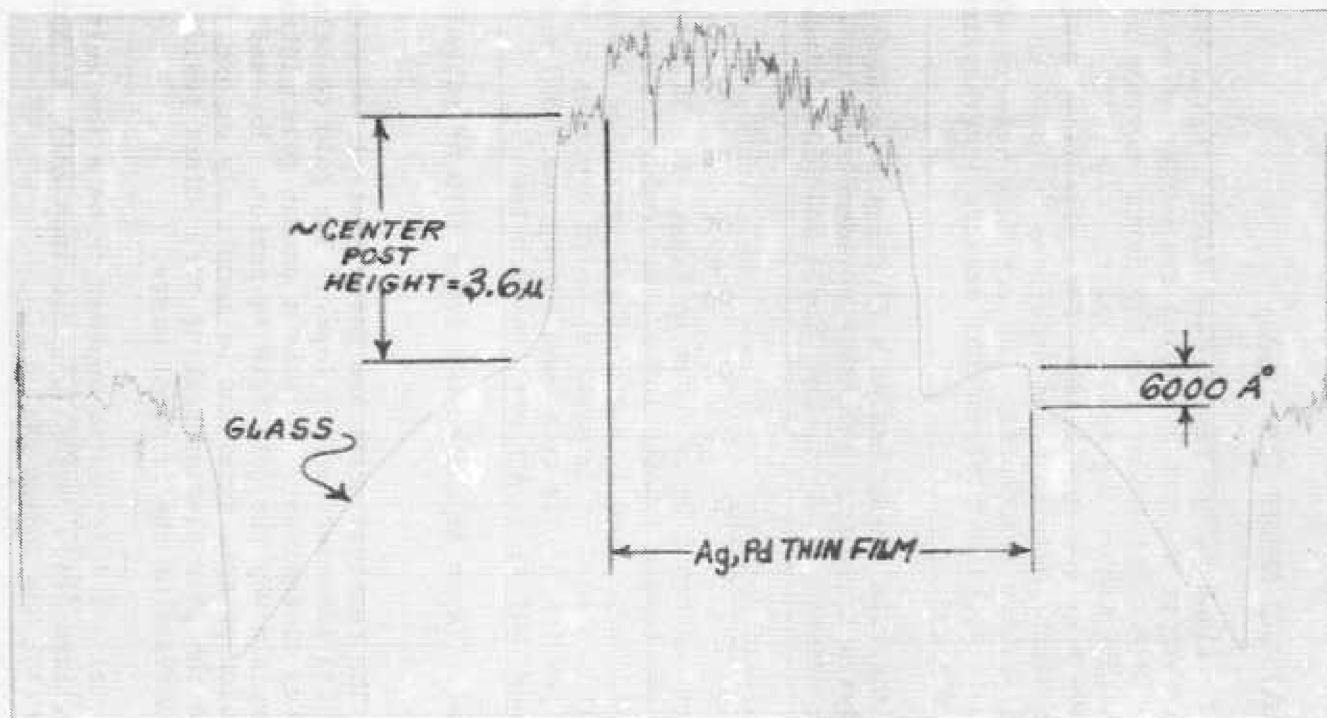


Figure 4. Photomicrograph and Profilometer Trace of Fuze Header Profilometer - 100X Horizontal, 100K Angstroms Full Scale Vertical. Fuze #4

D



Trace 2

Figure 4 (Concluded). Profilometer Trace 2
100X Horizontal, 100K Angstroms Full Scale Vertical. Fuze #4

APPENDIX E

RADC RELIABILITY EVALUATION OF DEPOSITED BRIDGE

MUNITION FUZE HEADER (P/N 10506)

Headquarters Armament Development and Test Center (AFSC), Eglin AFB Florida, requested RADC reliability support involving evaluation of munition fuze headers on 6 June 1974. Attachment 1 is the formal correspondence from Headquarters ADTC/SDY requesting RADC support. RADC/RBRP received thirty (30) PN 10506 munition fuze headers for reliability assessment. RADC's evaluation of header materials and processes indicate an inferior product from a reliability standpoint. Subject fuze headers are prototype samples for evaluation, rather than actual devices incorporated into current munition fuze designs.

This report documents the fuze header analysis findings as conducted by the RADC QR Failure Analysis Activity. RADC/RBRP personnel contributing to this project were Messrs. JJ. Bart, E.A. Doyle and D.J. Salvo.

Fuze Header Reliability Analysis Results:

The overall fuze header construction is shown in Figure 1. The thin film conductor between the two terminal posts forms a hot bridge, which is heated by a capacitive discharge from a 22 microfarad capacitor charged to 40 volts. The heat ignites a lead azide material which explodes at a temperature of 350°C. The results of electron beam microprobe (EBM) x-ray analysis identified the header materials and are listed below:

Thin form fuze material - Vapor deposited two layer film of palladium (Pd) and silver (Ag).

Conductor materials - The terminal posts are Kovar post-plated with gold (Au) over a chromium (Cr) adhesion-barrier layer. The gold contains a large amount of copper (Cu) contaminant. This is a common gold plating bath contaminant and may explain why the gold film is porous. Exposed Kovar exhibited rust corrosion on some fuzes and is completely exposed in spots on other fuzes due to the gold plating flaking off. Glass residue was also found on the top surface of the terminal posts.

Glass dielectric material - The insulator appears to be a low melting point glass containing: silicon (Si), oxygen (O), aluminum (Al), titanium (Ti), iron (Fe), potassium (K), and sodium (Na).

Electrical resistance measured 4.09 ohms average on 17 samples tested and varied from a minimum of 3.50 ohms to a maximum of 5.25 ohms. Profilometer trace normal to the neckdown region of the thin film measured a nominal film thickness of approximately 4,000 Angstroms. Profilometer traces from terminal post to terminal post indicate step heights, relative

roughness of materials, and general surface planarity variations. Step heights at the posts were as large as 70,000 Angstroms. Examples of typical profilometer traces are given in Figures 2 and 3. Optical and scanning electron beam microscope (SEM) photomicrographs show a variety of features found in several devices. Included are examples of thin film misalignment, gold flaking, rusting, bubbles in the glass, surface testure of plating on terminal posts, plating pop-outs, and glass defects in the thin film fuze region.

General Conclusions and Related Discussion:

a. Material Compatibility

Reference is made to RADC's report on fuze headers P/N 08892 dated April 74, for detailed discussion of materials compatibility. The comments apply in general, although the plating of the terminal posts and outside cylinder are Au-Cr, rather than Au-Ta used in P/N 08892.

b. Manufacturing Process Evaluation

In summary, the following process deficiences are noted in the subject (P/N 10506) fuze headers: (1) Poor plating over Kovar: a) Corrosion (rust) is evident on several samples indicating porosity incompatible with long term reliability; b) Flaking off of plating materials indicating poor adherence possibly caused by improper Kovar surface preparation Present Au post-plating minimum thickness spec for microcircuit packages (Kovar leads) is 50μ-in (1.25μ). Tests have shown that a continuous Au plate requires a minimum thickness of 25 - 35μ-in. Thus, a 50μ-in Au plating thickness is adequate provided the complete removal of the metal oxide, which is grown to facilitate glass to metal hermetic seals, does not roughen the surface of Kovar itself and plating is initiated immediately after oxide removal, that is, before the formation of native oxide from atmospheric exposure. This assures a relatively smooth metal plate with fair adherence properties. A thin Cr or Ti layer may be used prior to Au plating for better adherence observing the same precautions. Assuming a nominal 5000Å (0.5μ) total film thickness, the step height maximum ratio of 2:1 (12,500Å:5,000Å) is nearly achieved reducing the risk of opens at the post step. (2) Lack of glass insulator planarity leading to possible thin regions in the vapor deposited thin films during the deposition process. (3) Possibility of open circuit or premature burnout at lower than 350°C due to a) excessive step height to film thickness ratio, (terminal post to thin film fuze link); (ratio should not exceed 2:1); b) bubbles in the glass in the fuze region; c) small contact periphery afforded by the two terminal post electrode geometry; d) glass contamination on the posts. (4) Process control problem indicated by off centered thin film deposition and by fuze bottom thin film (Pd) deposition extending beyond top thin film (Ag) deposition on several devices. (5) Glass insulator containing many impurities which are possible long term sources of corrosion and/or

thin film contamination. Reference report on fuze P/N 08892 for further discussion of similar deficiences noted on that part.

c. Recommendations

RADC recommends that these headers not be considered for high reliability (20 year storage) applications. The problems noted on this part are more severe from a design and process standpoint than those noted in the RADC report on P/N 08892 fuze headers.

The basic concept of using a plated fuze link seems to have some merit. After giving careful consideration to the fuze header designs submitted for evaluation, the following design and process changes are suggested to possibly enhance reliability, refer to Figure 9a. The top view shows a split cylinder arrangement which allows the thin film fuze link to have maximum contact periphery over the glass to metal step. Alignment of the thin film is also less critical since the electrode contact is the entire half cylinder rather than a small post. A possible process sequence would be to start with a metal cylinder having a bottom but no top. Fill the interior of the cylinder with a high purity bubble free glass. Mechanically polish the top surface to achieve a smooth, planar surface with no step at the glass to metal interface. Use a laser, diamond blade, or air-abrasive to cut the metal cylinder in two. Cut down one side, across the bottom between the pins, and up the other side. (Alternately, one could start with two half cylinders and devise fixturing to keep the glass in place while it is molten). Apply a protective plating on the cylinder and pins assuring that the plating is fine grained having low porosity yet minimum thickness to assure that the step height from metal to glass does not exceed two (2) times the thickness of the thin film plating. Deposit the thin film fuze link by vapor deposition method and delineate by etching or masking during the plating process. Appropriate cleaning and surface preparation steps are assumed. Since the glass to metal seal does not have to hold a vacuum, it may be possible to use some other metal-insulator system in place of Kovar. This might permit dispensing with the plating operation required with the Kovar. Attachment 2 is extracted from "Handbook of Materials and Techniques for Vacuum Devices", Walter H. Kohl, Reinhold Publishing Corp., N.Y., 1967 and contains data on various glass-metal sealing systems.

Consideration should also be given to a system using a ceramic insulator in place of the glass, although no data on ceramic-metal seals is available at RBRP to determine compatibility.

One such configuration, similar to the P/N 10506 design, involves a ceramic (Al_2O_3) disc with swaged Au alloy terminals and thick film Au or Au alloy as the fuze link. The terminal lead cross-section can be any geometry other than circular to avoid lead rotation (See Figure 9b).

Another possible alternative is to adapt commercially available hybrid resistor chips to the fuze application. This would entail attachment of contact pins to the resistors, special trimming of the resistor element to insure a hot spot (normally designed out in normal resistor applications), and a determination of compatibility of the resistor materials with the lead azide environment and 350°C hot bridge temperature. This technology is very mature and a wide variety of substrates, contact pad materials, and resistive materials are available. Trimming to very precise values of resistance is achieved by a wide variety of methods and a consistent product is readily obtainable. Attached is descriptive literature of one manufacturer's thick film hybrid resistors (Attachment 3). Thin film resistors are also available in similar configuration. Lead attachment (contact pins) would appear to be the most difficult problem to be solved. Conventional flywire or reflow solder attachment do not appear compatible with this fuze application.

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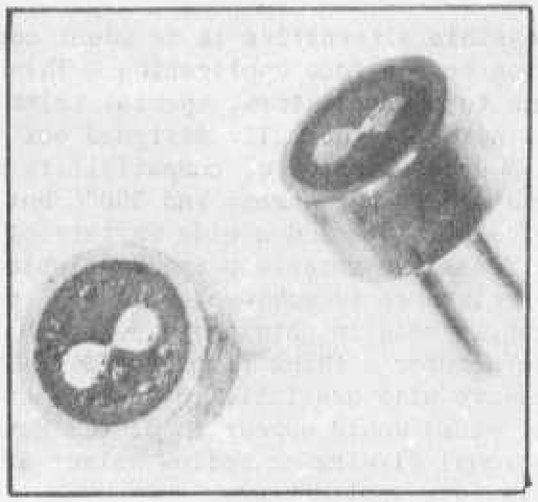


Figure 1. Fuze Overall Construction (Approx 13X)

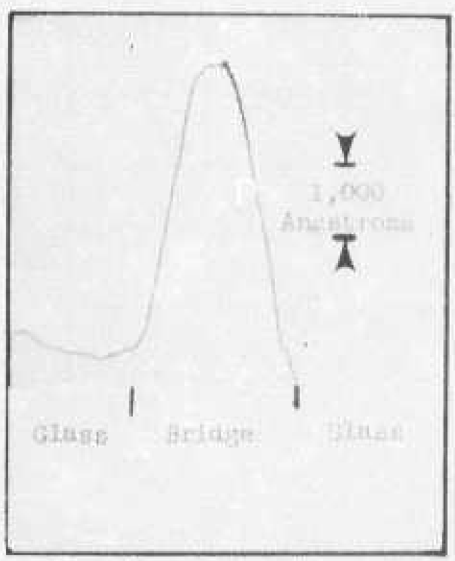


Figure 2. Profilometer Trace Normal to Neckdown Region of Fuze Thin Film. 1,000X Horiz.

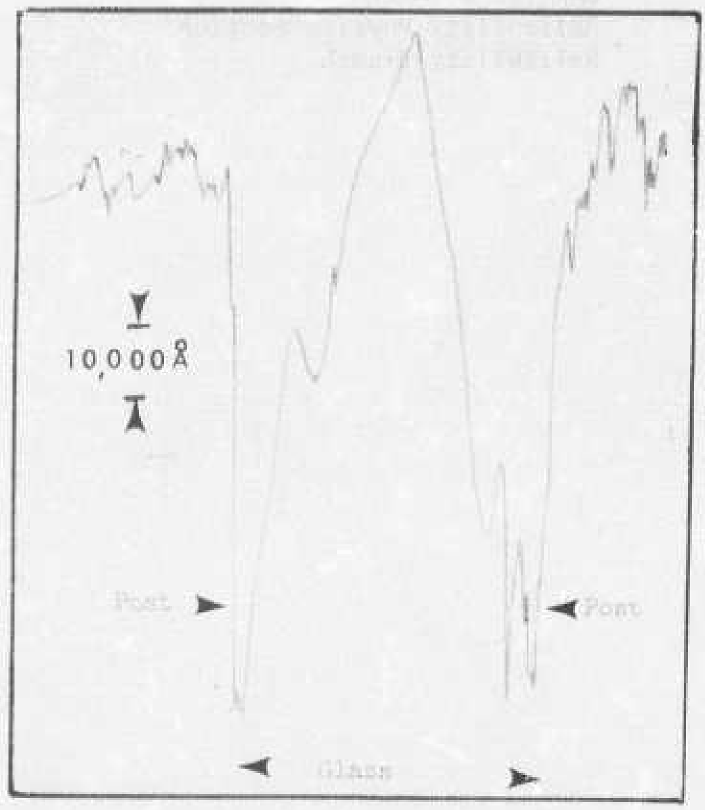
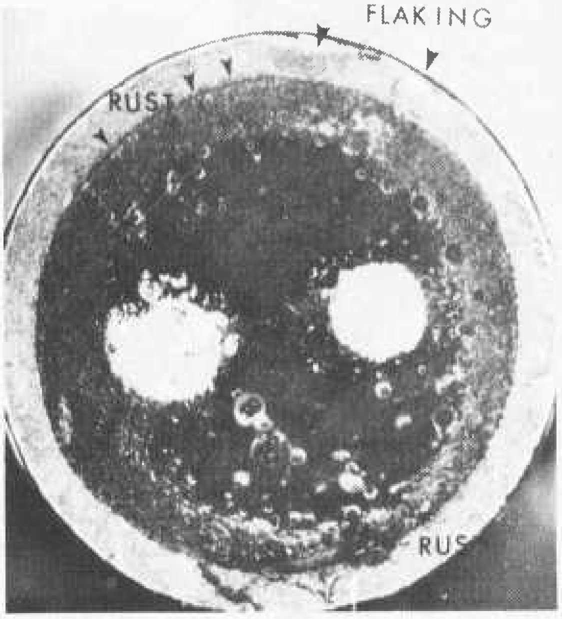
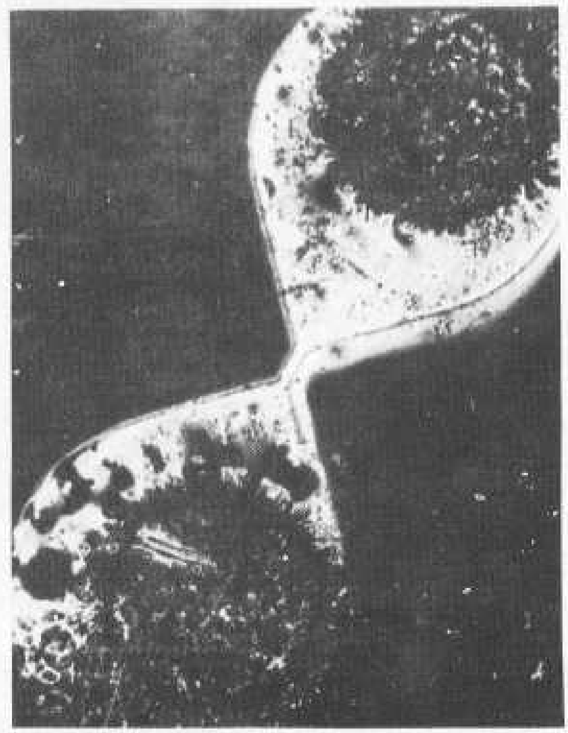


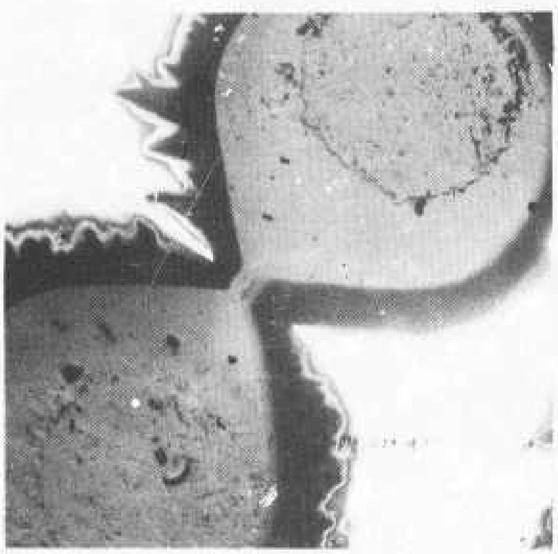
Figure 3. Profilometer Trace From Post to Post Showing Post Roughness, Metal-Glass Step, and Lack of Planarity of Glass in Fuze Link Region. 100,000 Angstroms Full Scale, 100X Horiz.



a) Dark Field 39X



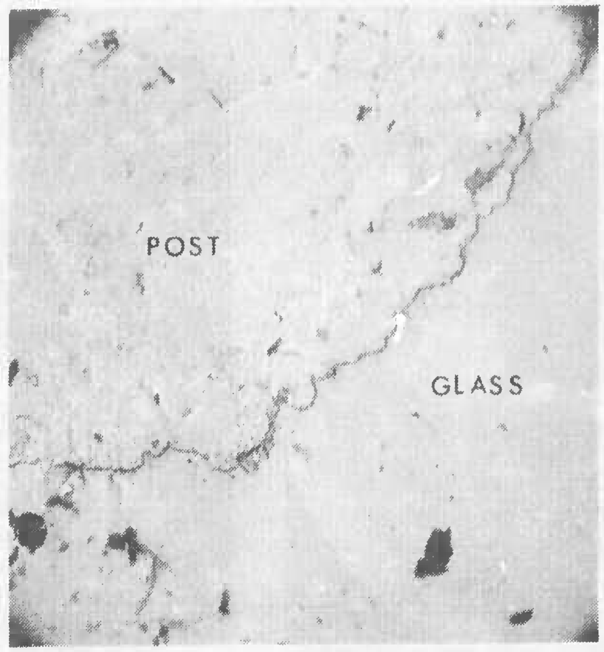
b) Bright Field 90X



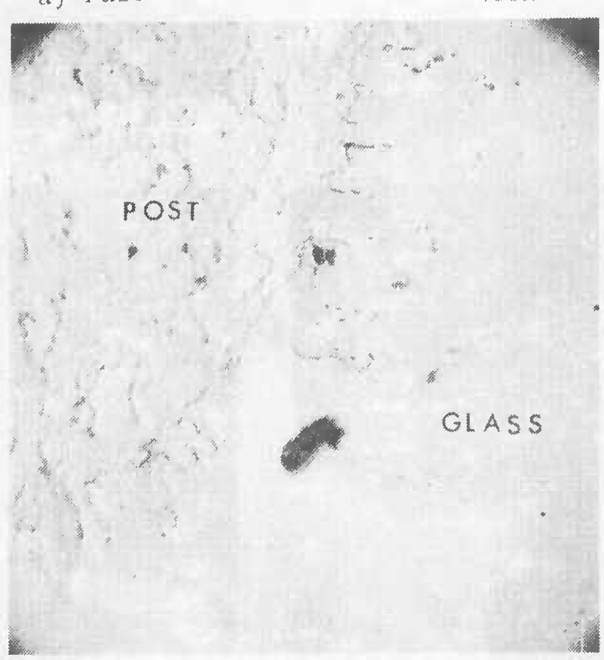
c) SEM 10kv 10° Tilt 80X

d) SEM 10kv 10° Tilt 400X

Figure 4. Fuze #1 a) Bubbles in glass; gold flaking; rusting; off centered thin film; b) Bottom layer of thin film extending beyond top layer; c) Holes in thin film and bottom layer extension; d) Bottom layer extending beyond top.

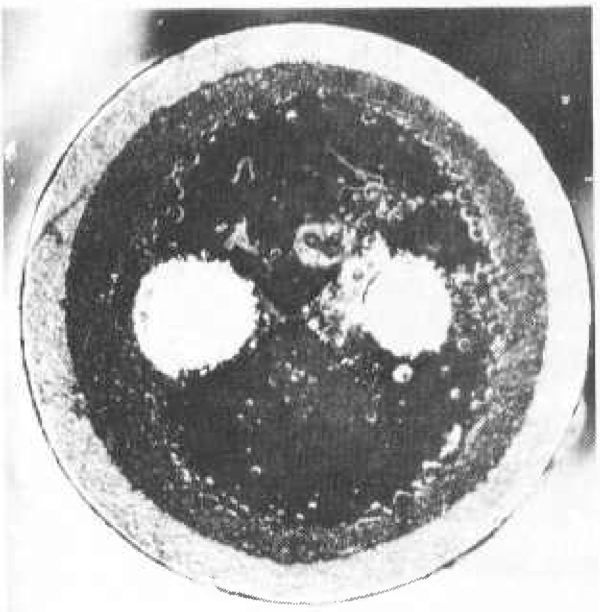


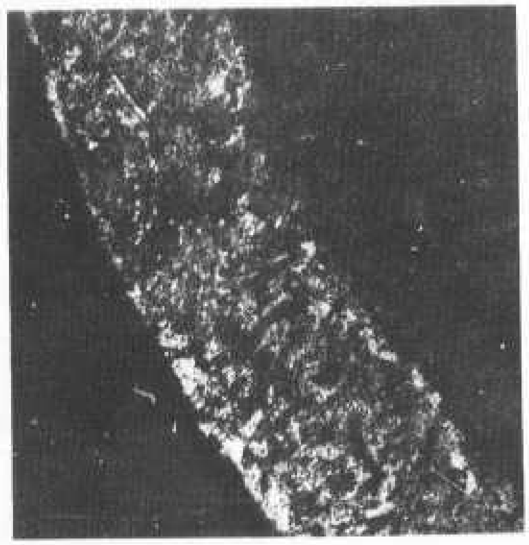
a) Fuze #1 400X



b) Fuze #2 400X

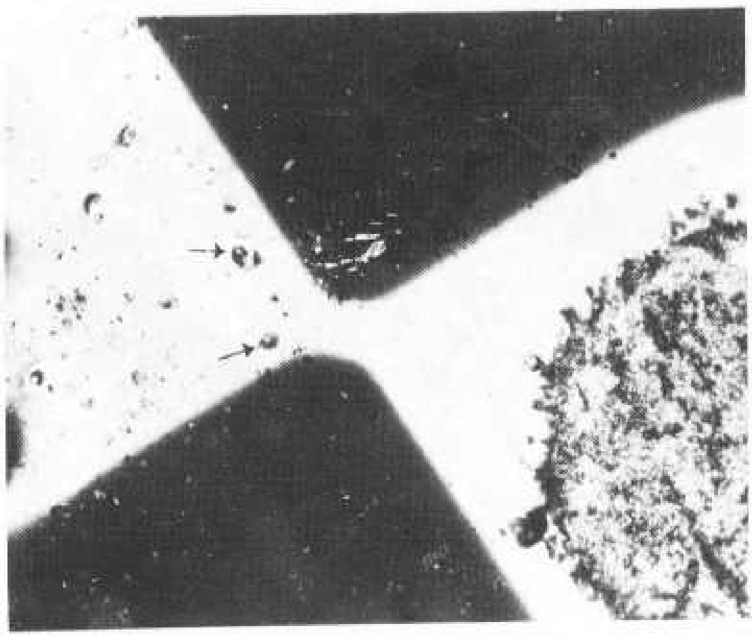
Figure 5. SEM Photographs Indicating Surface at Terminal Posts of Two Typcial Fuzes (Both Photographs Taken at 10kv, 10 Degree Tilt)





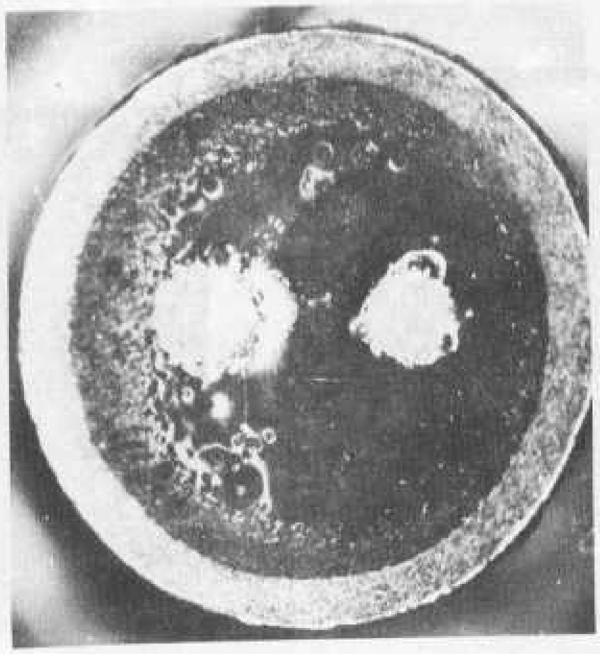
b) Bright Field

a) Dark Field 39X

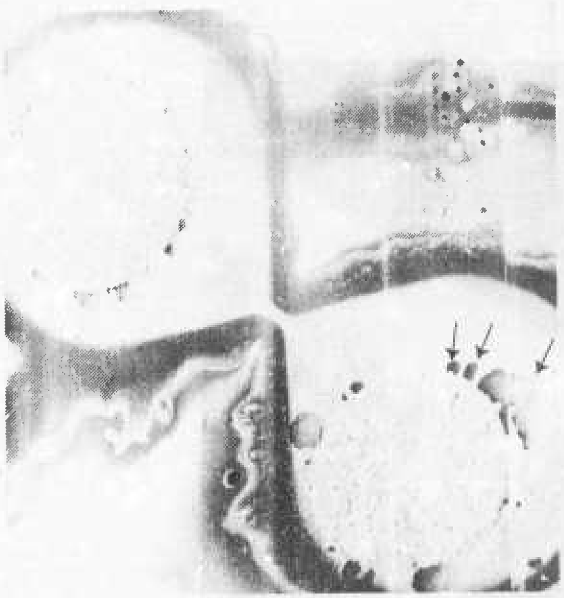


c) Bright Field

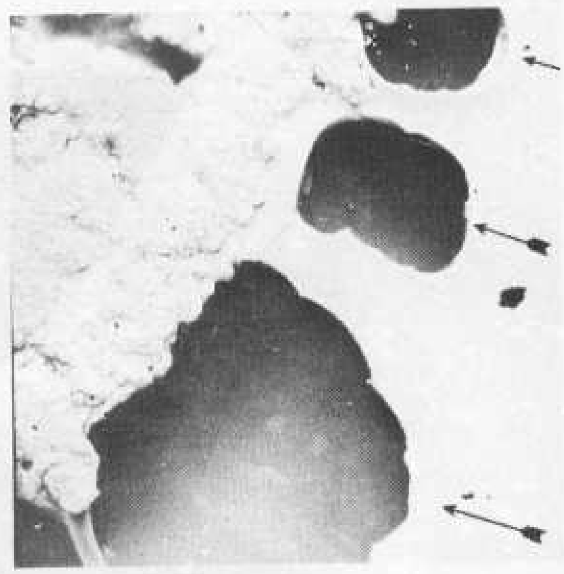
Figure 6. Fuze #7 a) Bubbles in Glass; gold flaking; rusting; b) Flaked Region of Outside Cylinder; c) Glass Defects in Fuze Thin Film Region



a) Dark Field 39X

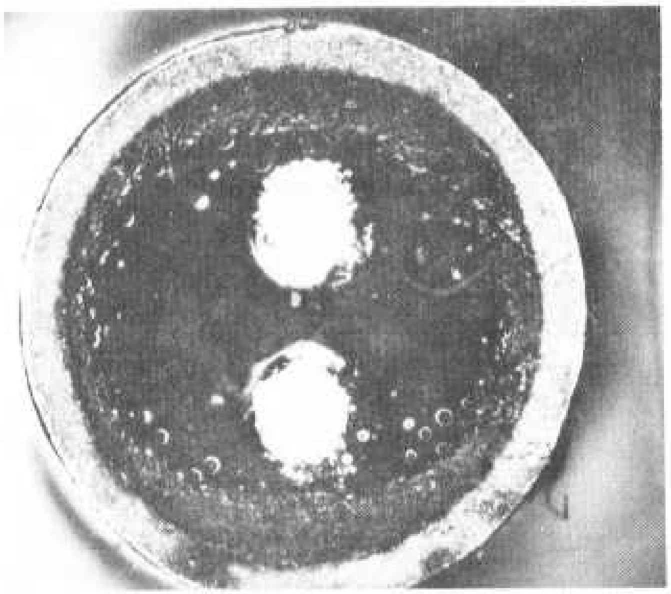


b) SEM 80X

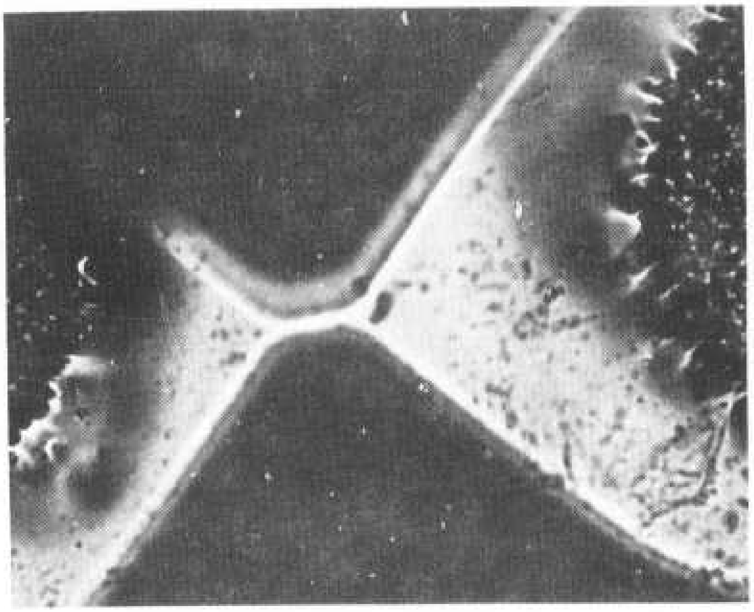


c) SEM 800X

Figure 7. Fuze #8 a) Bubbles in glass; rusting; b)&c) SEM showing plating popouts of the thin film around the posts apparently due to bubbles in glass. Note also the texture of post surface in c). SEM taken at 20kv and 10° tilt angle.



a) Dark Field 39X



b) Bright Field

Figure 8. Fuze #9 a) Bubbles in Glass; Rusting; b) Underplating Extending Beyond Overplating; Apparent Thinning of Top Plating in Neck-Down Region; it is possible that the narrowing seen in the top plating is due to etching of the thin film top layer such that the cross-section is triangular.

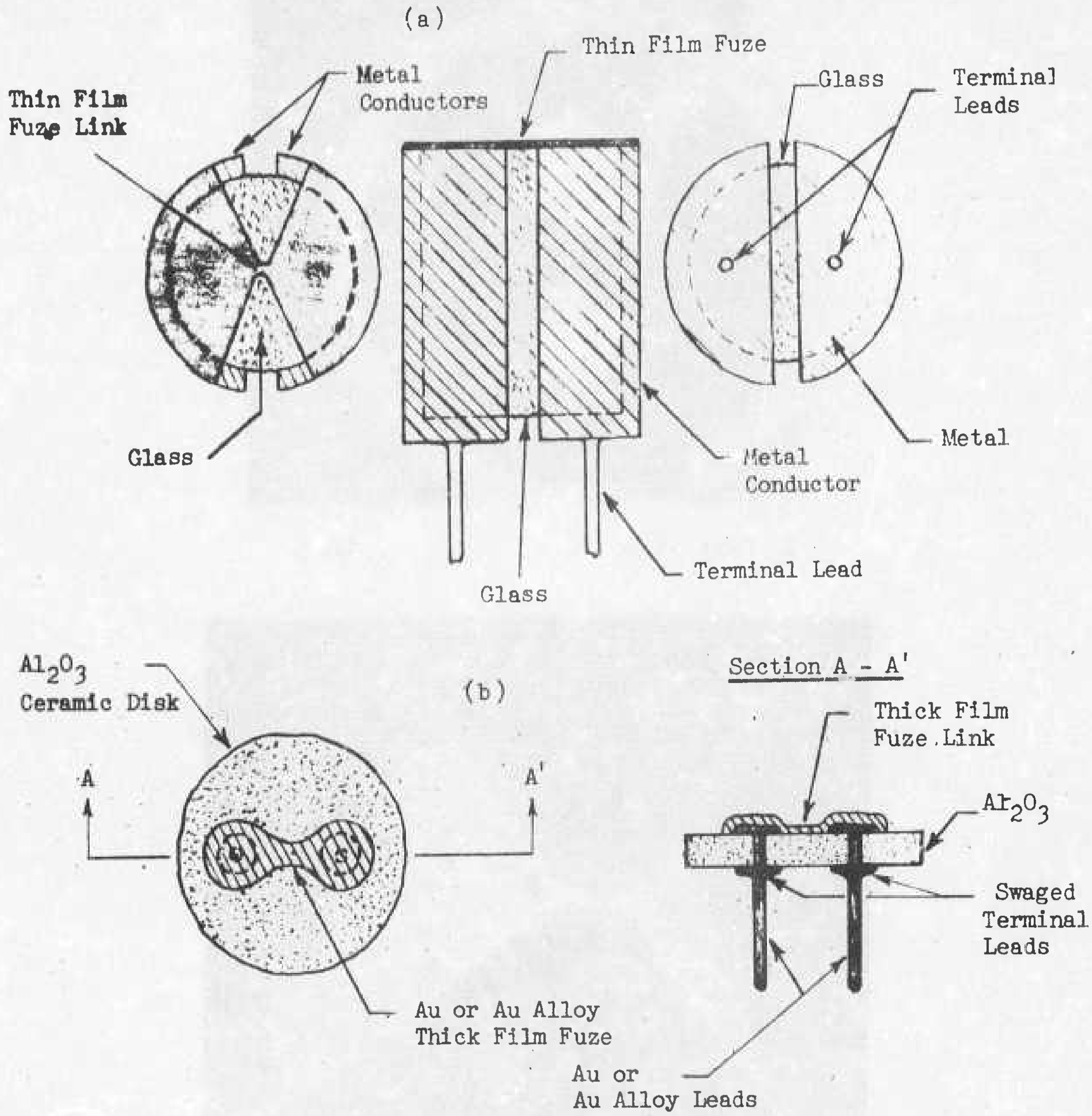


Figure 9. a) Split cylinder fuze header; b) Metal-ceramic disc alternate design

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